Crop Protection

WORLD CROPS

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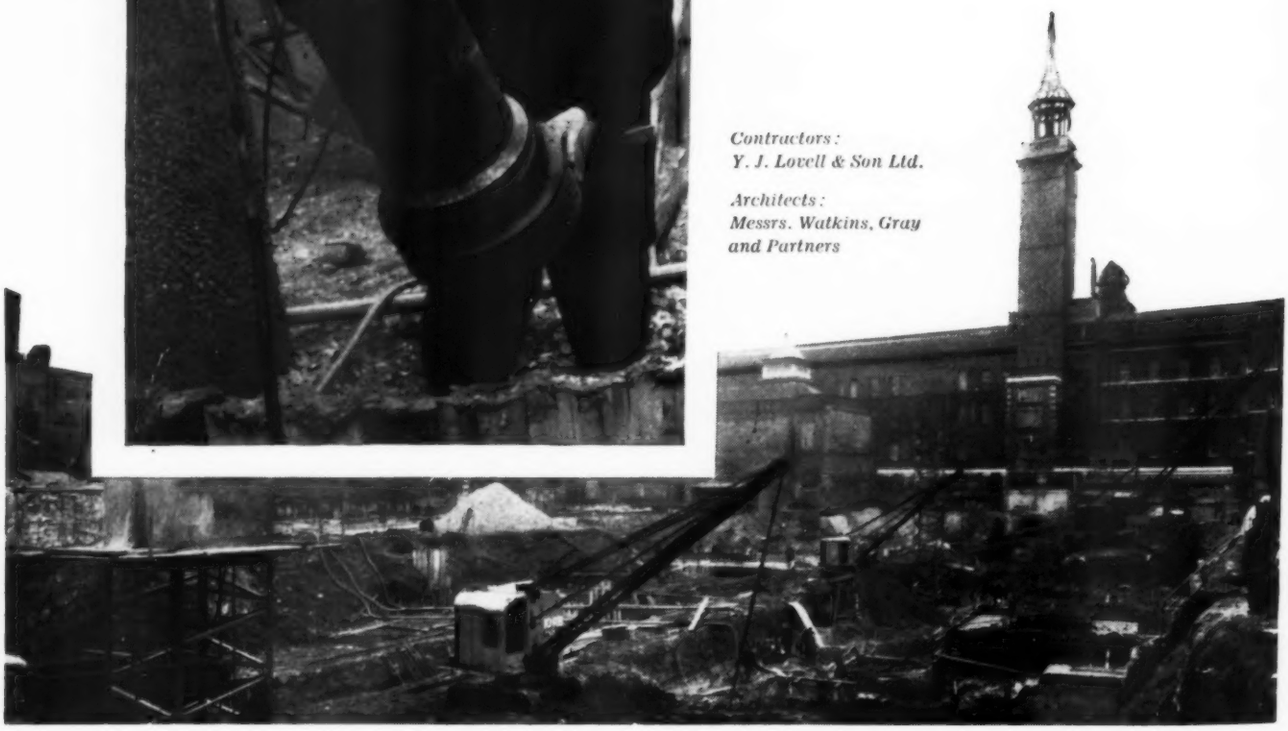
Spraying rice with 'Agroxone' in Italy (A Plant Protection picture)

Five Sumo Drainage Pumps turned the tide at the new Guy's Hospital Site

Contractors:
Y. J. Lovell & Son Ltd.

Architects:
Messrs. Watkins, Gray and Partners



INSOLUBLE? The Thames set an awkward pumping problem at this excavation for the new Guy's surgical block near London Bridge. Tidal seepage was such that conventional diesel-driven suction pumps either could not reach the water-level at low tide, or stood in danger of being flooded out at high tide.

UNFLOODABLE! Sumo came up with the answer. Five submersible drainage pumps began to swallow the silt-thickened water at a total rate of nearly 100,000 gallons an hour. With ⅜" strainers at the base, these units operate equally well fully submerged or 'on snore'.

LOWERED—AND LEFT! Easily installed, rugged in construction, running on and on without supervision or trouble, these are very much contractor's pumps. As the site foreman said—'Our only regret is that we didn't install Sumos in the first place'.

SUMO PUMPS LTD.

28 ST. JAMES'S SQUARE, LONDON, S.W.1. TELEPHONE: TRAFALGAR 1954

Editorial Comment

Pest infestation overseas

UNTIL RECENTLY the main objective of D.S.I.R. Pest Infestation Research has been control of insects in food stores, factories etc. and the disinfestation of imported foods. This is too limited – for infestation, like peace, is indivisible. Infestations that occur in overseas food on its way here, *en voyage* or even in stores in the producing countries, not only affect the food, but may establish bridgeheads for new infestations here. So far the Pest Infestation Research Laboratory has conducted liaison work with Colonial governments. It is now recommended – in the Laboratory's latest Report (H.M.S.O., 5*s*. net) – that the Laboratory should be able to take the initiative in tackling overseas problems.

The knowledge possessed by the Laboratory is probably unique, and its wider practical application overseas should greatly reduce food spoilage by pests; in special cases staff might have to be sent overseas to investigate problems that are complicated by local climatic conditions etc. There are few who would question the sense of this proposal, which must be of particular value to Commonwealth food-exporting countries.

Immunity to insecticides

THE NEW Pest Infestation Report gives further evidence of insect resistance to modern insecticides. This is no longer a problem of DDT alone. Grain weevils can breed generations with a fivefold increased resistance to pyrethrins. Houseflies can now become resistant to dieldrin, and the same strains have considerable resistance to gamma-BHC. The Report regards this problem as the most serious and challenging one facing insecticide research workers today, and the World Health Organisation has offered 'very substantial financial support' for the Laboratory's biochemical research on resistance development. Some insect species have now developed virtual immunity not to one insecticide, but to several – and this may undermine the striking progress made in food and health protection during the past 10 years.

Methods of storage

THERE ARE many items of special interest in the Report. Further work using phosphine – generated from tableted aluminium phosphide – as a fumigant is described. Analytical difficulties have limited the assessment of tests; a reliable method for determining the phosphine in air and in the presence of ammonia and carbon dioxide is required. At present, however, it is thought that fumigation with phosphine will find less use in the U.K. than overseas. Progress in the control of clothes moths by virus spraying appears to have been disappointing. In a large-scale test the spread of the virus infection among moth caterpillars has been slow, much slower than in smaller-scale tests in which conditions favoured the spread of the virus. This may be an indication that the biological approach to controlling the clothes or wool moth will not compete successfully with established chemical methods.

The development of insect-proof packaging materials is stressed as an urgent need. As many as fifteen types of material are being tested; the penetrative ability of different insects seems to vary appreciably, but so far five-ply kraft paper and polythene film appear to offer a range of resistance that may be promising. Tests with insecticide-impregnated jute have shown some practical disadvantages.

Plants have heart attacks

ENORMOUS LOSSES are sustained by farmers throughout the world from the ravages of *Fusarium* wilt, which attacks a wide variety of crops, including cabbages, peas, tomatoes, bananas, and other important food plants. At the 133rd national meeting of the American Chemical Society, held recently in San Francisco, news was given of research work which is now being carried out on its cause and prevention. Describing the effect of the disease, Dr. Mark A. Stahmann, professor of biochemistry at the University of Wisconsin, likened it to a stroke or heart attack in humans. The *Fusarium* organism, he said, may invade the plant's vascular system, and produce an enzyme which attacks some of the pectin in the walls of the vessels. Pectin fragments then get into the vascular stream, where they form gelatinised masses that plug the conducting vessels, just as blood clots block the blood vessels of humans.

With this new understanding of the nature of wilt diseases, research workers have now embarked on a study of the more difficult subject of disease resistance. They have studied certain plants which are resistant to the effects of the causative fungi, and shown that, although this can exist for several weeks in the tissues of resistant plants, its effects are slight and transitory, and the fungi rather than the host plant eventually succumbs. Although the defence mechanism has not been completely identified, Dr. Stahmann stated that resistant plants seemed to produce in their respiratory

system some substance which becomes toxic to the fungi. In addition, such plants apparently failed to produce enough of another enzyme, known as depolymerase, which is responsible for the formation of the pectin plugs. He also noted that the fungi seemed to produce less of the pectic enzymes when grown on the tissue of resistant plants and suggested that methods of culturing of the parasite on the host plant in this way might provide a valuable tool in the development of resistant varieties. Preliminary experiments had already shown that the strain of *Fusarium* responsible for Panama disease in bananas grew well on the tissue of the susceptible varieties, Gros Michel and Ecuador, but not at all on tissue from the resistant varieties, Lacatan and Valery. Poor growth was observed on the tissues of Viamana and Tumoc, which were also classified as resistant.

Perfecting a crop-protecting chemical

Sir,

This somewhat challenging title for the article which appeared on page 260 of the July issue of WORLD CROPS is disappointing in its lack of fulfilment. Surely no crop-protecting chemical can be regarded as proven perfect unless it meets one of the most important requirements, *viz.* the complete absence of any tainting of the product by odour or flavour. I can find neither reference to, nor hint of, any such examination in the scheme discussed in the article.

The crop is of no value unless it is consumed and, if, however well perfected in other ways, there is any odour or flavour derived, directly or indirectly, through cooking or processing, then, as far as the consumer is concerned, the crop is a failure.

We still have vivid recollections of ' protected ' potatoes being rejected by the housewives, and of ' protected ' carrot seeds which gave crops completely unsuitable for canning, due to a most objectionable flavour which had carried through the growing stage and was intensified during processing in the can.

It would be most informative to have a follow-up article in which we can be told more about this side of the problem.

Yours faithfully,

F. H. BANFIELD,
Director of Research.

British Food Manufacturing Industries Research Association, Leatherhead, Surrey.

The article in question dealt only with the formulation research carried out in the new laboratory of Plant Protection Ltd. at Yalding in Kent. The investigation of problems of odour and flavour is done at their biological research station at Fernhurst in Surrey. An article on this subject is in preparation.

Too much and too often

WE CANNOT EMPHASISE too much that users of agricultural chemicals, some of which are toxic to man, for the control or extermination of pests must strictly follow the instructions on the container or package. This may be stating the obvious, but the temptation to apply double the dosage or apply the correct dosage more frequently than is recommended, just ' for good measure ', is always there.

It may not be generally appreciated that these instructions are the results of exhaustive research which every reputable firm carries out before launching a new formulation and, in effect, these ' instructions ' have really the force of ' orders '. So many people like to go one better and do a bit of ' research ' for themselves and not infrequently damn the product when the results are unsatisfactory. Recent research in the U.S.A. on the application of insecticides, in excessive amounts or at too frequent intervals, has shown that such practices may adversely affect the flavour and aroma, and even the texture, shape and size of the crop.

The preliminary investigations have established that some insecticides may, under certain conditions, accumulate in the soil and build up a dangerous excess, and where a grower rotates his crops the safe treatment of one crop may produce an off-flavour or taint in the succeeding crop; this is particularly so in the case of a sub-surface crop.

Research in this field is not at all easy because of the many complicating factors of temperature, rainfall, incidence of rainfall, the physical and chemical nature of the soil, the immense variety of crops and weeds, and their age and condition, and finally the vast range of different formulations to be considered, often of the same product. At the New Jersey Experimental Station, for example, they have what might be considered an extensive programme of 7,000 quality tests on eight different vegetables, grown on a single soil – a sandy loam and using only two insecticides – DDT and chlordane. This investigation is, in fact, only a small fraction of the work that is waiting to be done in this vast new field of research and to quote the results of a few preliminary trials would only be tinkering with the twin problems of taint and toxicity.

Taint in coffee

DURING RECENT years shipowners who regularly carry coffee to the port of Hamburg have been concerned at the large claims for damage by taint raised against them by the owners of the cargo. An investigation was therefore instituted to determine the causes of the taint, and the results obtained are of considerable interest.*

There are, of course, several ways in which taint may be acquired. Investigations in Brazil have shown that a so-called ' hospital ' taint is characteristic of hard coffees from the Rio and Victoria districts. In northern Brazil iodoform is produced in the soil by the metabolic activity of certain types of bacteria and it is possible that this may be absorbed by the plant and so give rise to the objectionable flavour. Similar absorption of noxious substances from the asphaltic subsoil in northern Brazil, Venezuela and Mexico, and from subsoil containing petroleum in the last two countries, is thought to be responsible for off-flavours variously described as resembling asphalt, tar and fuel oil.

The suggestion is made that taints may also result

*Reported in ' Damage to Coffee by Taint ' by Dr. R. F. Milton, B.SC., PH.D., F.R.I.C., M.I.BIOL., published by the U.K. Mutual Steamship Assurance Association.

from the use of insecticides, such as DDT, BHC, aldrin, dieldrin etc., which are often sprayed on the trees as tar-oil emulsions. The residual material is said to impart a taint vaguely described as ' chemical ', and it is thought that this taint could also arise by absorption by the plant of spray material falling on the soil. Toxophene, an insecticide consisting of camphene hydrochloride, may similarly be responsible for camphor taint, and flavours due to naphthalene and p-dichlorobenzene are attributed to the occasional use of these substances as insecticides.

Musty and fermented flavours were also encountered where dampness in the beans themselves, or the sacks containing them, had allowed the occurrence of microbiological growth. Fermentation forms an integral part of one method of treating harvested beans, but wet weather and incorrect processing could result in this fermentation being carried too far, with resulting off-flavours.

Chemical and other taints could also arise from faulty storage of the coffee in proximity to various odoriferous materials either before, during or after shipment. An obnoxious taint, for instance, might result if coffee is stored alongside animal hides or fertilisers of animal origin, or is transported in vehicles previously used to carry these substances.

The report points out that many of these odours are volatilised when the coffee is roasted, and therefore do not affect the coffee as consumed. In other cases deodorisation can be effected by special treatment, ozonisation being one of the procedures.

It is obvious that the traditional practice of packaging coffee in open jute bags gives insufficient protection and that the use of polythene liners would be of considerable value in protecting coffee from taint.

Pre-crop or pre-weed

WITH REGARD to the editorial comment which appeared in our August issue, we have received the the following communication from Prof. G. E. Blackman, of Oxford University:

' It is agreed that the English language, like Topsy, " just grows up ", but it is as well, before changing a meaning, to go back and examine the beginning. The technique of pre-emergence spraying was developed in the early stages of World War II and was described by me in an article in the *Journal of the Ministry of Agriculture* (1943, **49**, 219). From the context it is clear that the word " pre-emergence " was coined to describe a technique for killing the weeds which had already germinated before the crop had emerged above ground. Admittedly, the term is now used indiscriminately for spray applications to the seedbed, and if a new phrase is now needed, to avoid confusion it should be " pre-weed-emergence ", not " pre-crop-emergence " '.

Ladybirds

ELSEWHERE IN this issue, on page 411, there is an interesting account of the wholesale collection of ladybirds to be used for the biological control of certain crop-consuming pests, such as spider mites on cotton, aphids on lettuce and plant scale insects. In parts of Arizona, Idaho, Utah and California these useful insects are to be found swarming in their millions and can be collected by the bucketful and they are kept in cold storage till required. They are sent by parcel post or by air mail to farmers and market gardeners, as and when required.

It has occurred to us that the principle could be further extended for the control of mealy bugs on pineapple and yellow scale on coconuts and of aphids on a variety of temperate and tropical crops by the despatch by air of suitable varieties which could be bred or collected in countries where the conditions are most suitable and delivered in a day to countries where they are needed, even though the conditions may not be so suitable for their mass reproduction in those countries.

Free trade

THE DYNAMIC and dominating position of the agricultural engineering industry of the U.K. is in no small measure due to the existence of the Agricultural Engineers' Association and the goodwill and co-operation which has been generated among its members by the retiring President, Mr. Lionel Harper, of Massey-Ferguson Ltd., and by its indefatigable Secretary, Air Vice-Marshal F. L. Hopps.

The Association held its Annual Conference last month at Selsdon Park, near London, when the main subject under discussion was the European Free Trade Area. The guest speaker was Sir Norman Kipping, Director-General of the Federation of British Industries, who, speaking entirely without notes, outlined in masterly fashion the problems that require to be solved before the Free Trade Area can be successfully established.

The proposal originally arose from the deep-seated longing of the people of certain European countries for economic security, the basic idea being that the formation of a Free Trade Area would increase the volume of inter-nation trade and thus ensure mutual prosperity. The parallel, often quoted, is that extensive land area on the other side of the Atlantic – the U.S.A. – where there are no tariff barriers whatever between the constituent states.

The situation in Europe is, however, much more complicated by differences of race, of language and of currencies; by the system of passports which prevents the free movement of labour from one country to another; by differing wage levels and social welfare systems; and by problems of transportation due to differences in handling facilities and in the strength and width of the roads. Possibly the most serious problem of all is the definition of the ' true origin ' of a finished product.

According to Sir Norman, this can be overcome in one of two ways. Either by defining percentage content or by a definition of the degree of processing necessary

to establish the true origin. Thus a simple printing on a textile, or an assembly of parts, or a compounding of ingredients, with a small addition, would not qualify. Naturally, an appeals board would be necessary, but this would mean that each participating nation would have to surrender its sovereignty to this supra-national institution.

Individual countries who are traditionally protectionist may obstruct the development of the scheme in an obstinate desire to protect their own industries and raw materials, but even on this point Sir Norman was optimistic, because if a nation remains out of the Free Trade Area it will lose the whole of its existing trade in that area when the scheme comes into effect. Thus no nation can afford to remain out.

Sir Norman was confident that the Free Trade Area will come because it must come. We were happy to learn, however, that it will not be for some 10 to 12 years, because this is an assurance that nothing will be done in a precipitate hurry. He concluded with a useful comment on its effect on agriculture, which he considers is not going to be a major difficulty.

Marketing West Indian products

CONCERN IS FELT in the West Indies regarding the apparent failure of the Board of Trade to foster the import into the U.K. of West Indian agricultural products. Industries in bananas, grapefruit, cigars and honey, for instance, have been built up as the result of much research and considerable capital investment. Producers naturally hoped to place their products on the home market. They feel, however, that as soon as production of a commodity has been built up, U.K. quotas have been varied to operate in favour of non-Commonwealth countries and against the interests of the West Indies.

In support of this contention, *The West India Committee Circular* of July 1958 instances the U.K. Trade Agreement with Cuba, which allows for the import in 1958 of over a million dollars worth of cigars from that country, as compared with half a million six years ago – to the detriment of the West Indies cigar industry. Again, after years of research, the West Indies are now in a position to export bananas and grapefruit of excellent quality only to find that they cannot profit by their enterprise because new U.K. quotas for Cuban grapefruit and new quotas for dollar bananas operate against their products. Similarly, the annual value of honey that may be imported into the U.K. from the dollar area has recently been increased, despite the knowledge that Jamaica has a quantity of excellent honey which she has been unable to sell.

What is really needed are expanding markets for the few things that the West Indies can produce for export, and, above all, practical encouragement. Even without the intervention of the Board of Trade these territories are faced with contracting markets, and such outlets as they have been able to maintain, *e.g.* the continent of Europe, seem doomed to disappear when the European Common Market gets into its stride.

While we cannot believe that the Board of Trade is deliberately thwarting the aspirations of the West Indies, it does appear that they have taken an unimaginative view of the situation. We can therefore appreciate the feeling of frustration in the West Indies arising from a seeming indifference to her present predicament. The islands are faced with formidable economic problems – generally very poor natural resources, a rapidly expanding population and widespread unemployment resulting in indiscriminate emigration. Present expressions of goodwill towards the peoples of the West Indies must therefore be supported by vigorous action.

Sir J. Campbell, President of the West India Committee, has recently pointed out that the British people settled in the West Indies, built up its industries and set the social patterns which created present demands; the Mother Country cannot therefore now set aside ethical considerations. The West Indies, he said, did not want to be dependent upon economic aid, but they do want Britain's support in building up their industry and commerce. We concur with this view, for it is surely more dignified to assist the economic independence of the West Indies than to grant posthumous aid after the slow death of her agricultural industries.

Bees and spraying

IN NEW ZEALAND, where the production of honey is an important industry, the aerial application of pesticides has apparently provoked more complaints about bee losses than ground-based applications. A system of permits for aerial spraying operations has been developed, but ground applications can, of course, be no less dangerous—the systemic bee-toxic effect, lasting for several days after the application, would be as lethal to bees whether the pesticide was ground sprayed or air sprayed. There does not, however, appear to be any system of control for ground applications; the spotlight of criticism has been focused only upon the aerial operation. There is no doubt a need for more data about bee-pesticide relationships.

According to the *Lawrence Robinson Newsletter*, growers of melons, cucumbers and pumpkins in the U.S.A. are becoming increasingly aware of the importance of the common honey bee, *Apis mellifica*, as the main pollinating agent, since wild insects are rarely present in sufficient numbers on a field crop to do an effective job. They are actually renting hives of bees in order to obtain increased settings of fruit.

This, of course, creates a problem in use of insecticides (particularly those with residual effects) and in the matter of applying them, so that there will be no damage to the bees.

The Story of Agricultural Chemicals

By A SPECIAL CORRESPONDENT

This is an account of the principal agricultural chemicals now in common use.

THE agricultural chemicals industry – chemicals used in agriculture and horticulture for the protection of growing crops against the ravages of insect pests and fungus diseases and the competition from weeds – has progressed so rapidly in recent years that only specialists can keep pace with developments.

Up to about 1940, progress was steady and conventional on the basis of insecticides of natural origin like nicotine, pyrethrum, rotenone, and mineral oils; stomach poisons, like arsenic and fluorides; and fungicides based on sulphur and copper.

From the early war years onwards, the field of activity widened spectacularly, with the introduction of DDT, BHC, the organo-phosphorus insecticides, the selective herbicides and the organic fungicides. Its extent can now be judged by the extensive patent literature, the number of specialist technical periodicals devoted to it, and by the legislation governing the use of agricultural chemicals, which has been introduced in many countries.

Intensive research

War-time raw material shortages, the necessity for greatly increasing food production the world over, the post-war economic situation, international competition and the demand for improved quality in produce, parallel activities in the field of human insect and disease control by WHO, all stimulated intensive research into every means of crop protection. The problem was – and still is – of utmost international urgency. World population is estimated to be increasing by 55,000 to 80,000 per day. Two-thirds of the world's people are undernourished and an increase in food production of 50–70% is required. In this task the proper use of insecticides, fungicides and herbicides must all play a vital part.

It is impossible, within the compass of this brief survey, to do more than indicate the main stages in the development of crop protection by chemicals. The usual references can be found to the use of 'insecticides' in early times, from Homer onwards – sulphur, salt, arsenic, vegetable decoctions of various kinds – and to fantastic formulae, frequently based on the assumption that to control an unpleasant pest it was essential to use an unpleasant-smelling mixture.

Insecticides of vegetable origin

Nicotine, for long one of the most widely used contact insecticides, was first employed as a crude extract in 1690 in France against the pear lacebug (tobacco had been brought to Europe in 1559); extracts or decoctions found increasing application till the introduction of a standardised nicotine sulphate of 40% alkaloid content about 1910. Nicotine dusts were introduced in 1917.

The insecticidal use of *pyrethrum* originated in Persia at an unknown date. It was introduced into Europe in the early 19th century and became well known as 'Dalmatian insect powder'. The modern development of the pyrethrum industry dates from its introduction into Japan in 1881 and into Kenya in 1928. The closely related allethrin was synthesised in 1949.

Extracts from the roots of certain leguminous plants, such as *derris* and *lonchocarpus*, had for many centuries been used as fish poisons in the East, but their first use as insecticides is recorded in 1848. Commercially the use of *rotenone*, and allied constituents of the roots, stems from the McDougall patent of 1911, but their popularity, due to their wide sphere of usefulness and their non-poisonous nature, dates from about 1920.

The extensive use of these and other insecticides of natural origin and the isolation of their active principles greatly encouraged research on the relationship between chemical structure and biological activity. They still have great usefulness for various purposes, but their consumption has substantially decreased with the advent of

Photo: Shell

Trials carried out by the National Agricultural Advisory Service to determine the relative values of seed dressings. The centre plot was treated with mercury alone; the adjacent plots with mercury plus dieldrin. The effects of severe attack by wheat bulb fly and heavy weed infestation can be seen

the synthetic organic compounds, generally of greater stability and obviously capable of stricter standardisation.

Insecticides of mineral origin

The use of *petroleum oils* began in 1877 with kerosene-soap emulsions for scale insect control on citrus, although an attempt to use the unemulsified oil had been made in 1865. With the work of J. B. Smith on heavier oils in 1897 began the gradual study of the insecticidal and phytotoxic properties of petroleum oils in relation to their boiling range, viscosity, volatility and unsulphonatable residue and their formulation (1920–30) into dormant and summer sprays. In this period there appeared also white oil emulsions for glasshouse work and, some years later, oil emulsions with added toxicants, such as derris extracts, dinitrocresol and organic thiocyanates.

Emulsifiable concentrates made from *coal tar* distillates (winter washes) were first used in Germany and Holland about 1920 and were developed in England in 1921–22 with such success that in 1941 the Ministry of Agriculture stated that ' the introduction of tar oil washes in this country . . . resulted in the greatest advance in the control of fruit pests that had been made during the present century '. Though they are still regularly used, they have to an appreciable degree been superseded by spring washes based on DDT and BHC.

The only *arsenic* compound commonly used in this country – and, up to the arrival of the synthetic organic pesticides, the most widely used insecticide throughout the world – is lead arsenate. It was first used in 1894, as a result of the promise shown by lead acetate/sodium arsenate mixtures in the control of the gipsy moth in Massachusetts two years earlier. Its predecessor in popularity was Paris green (a copper aceto-arsenite), the use of which spread rapidly from 1865, when the Colorado beetle had already started its eastward migration. This appears to have been the first large-scale use of an insecticide. The necessity for ensuring the quality of Paris green and its freedom from phytotoxic effects gave rise to the first State insecticide laws in 1900. Calcium arsenate, now mainly used against cotton boll weevil, began to be extensively used about 1906.

Fungicides

The early history of *sulphur* is confused; it had certainly been used from early times in some form or another, but its status began to be established with its recommendation by Robertson for peach mildew in 1821 and by Knight for peach leaf curl in 1834. In modern forms (colloidal, micronised, dispersible) it has maintained its position ever since. Dusting with sulphur started with Duchâtel in 1850. The most popular and still widely used sulphur fungicide is lime sulphur, an aqueous solution of calcium ' pentasulphide '. Earlier mixtures of this kind are on record, but its real start dates from Grison's preparation of a boiled mixture (Eau Grison) at Versailles in 1851 to control powdery mildew of vine. From its use as a sheep dip in Australia and against San José scale in California, it became a standard fungicide in this country from 1906 onwards.

Copper, too, in various forms had long been used as a fungicide, particularly for seed treatment, and Proust, in 1800, first investigated copper sulphate-lime mixtures, but the well-known rediscovery by Millardet of ' Bordeaux mixture ' did not occur till 1882, in the course of his work on the control of downy mildew of vine. Thence came Burgundy mixture (Masson, 1887), the cuprammonium solution ' Eau Celeste ' (Audoynaud, 1886), copper oxychloride (early 1900's), basic copper carbonate (von Tubeuf, 1902; Darnell-Smith, 1915), cuprous oxide (Horsfall, 1932 onwards) and various other copper compounds.

Organic mercury fungicides are the basis of modern seed dressings, originating from Riehm's work on wheat smut in 1913; Ehrlich had given the lead with his organic arsenic compounds for the treatment of syphilis. Many organic mercurials are now used as foliage fungicides, such as the phenyl mercury chloride, nitrate, acetate and oxine.

Synthetic organic insecticides

Du Pont research from 1931 and American patents from 1934 on *dithiocarbamates* began, in Horsfall's words, ' the modern scramble for organic fungicides ', from which emerged the ferric and zinc dimethyldithiocarbamates (ferbam and ziram) and the sodium and zinc ethylene bisdithiocarbamates (nabam and zineb, 1943), as well as the related thiram (1931), hitherto used as a rubber accelerator. Many other organic fungicides have achieved substantial practical usage, the two most used in this country being, perhaps, dinitrocaprylphenyl crotonate (introduced in 1934 as an acaricide) and trichloromethylthiotetrahydrophthalimide, known as captan (1949).

The history of *DDT* is well known, from its original synthesis by Zeidler in 1874 to the discovery of its insecticidal properties in 1939 in the Geigy laboratories in the course of work on mothproofing chemicals. Its unprecedented development during the war was due to its ready synthesis, stability, low mammalian toxicity and exceptionally wide range of insecticidal activity. From this work came, directly or indirectly, a long list of compounds, a number of which have established themselves as useful insecticides or acaricides (chlorobenzilate, chlorbenside, fenson and chlorfenson).

Photo: Shell

A high-volume boom sprayer spraying DNBP on a crop of peas. This material is poisonous and the operator drives in a fully-enclosed cabin

Kenya — Treating a tea bush with a copper fungicide using a Favori-Colibri sprayer

East Africa — a coffee tree being banded with Dieldrex 15 to control ants

Parallel with the development of DDT was that of *BHC*, again a known chemical (Faraday, 1825) whose insecticidal properties were discovered in the laboratories of Imperial Chemical Industries Ltd. in 1942, although French workers had been investigating the crude product from 1940. The discovery of the activity of the gamma isomer is due to the former. The name lindane, given to this isomer when of minimum 99% purity, commemorates Van der Linden, who in 1912 established the existence of four isomers.

The multiplicity of uses, rapidity of development and world-wide production of both DDT and BHC make them outstanding in crop protection and other fields. They have been supplemented in more recent years by two other chlorinated hydrocarbon insecticides, aldrin and dieldrin (Hyman, 1948), which have special merits as soil insecticides and have largely superseded them for many soil applications.

As wide in their usefulness are the *organic phosphorus* insecticides, which originated in the work of Schrader from 1939 onwards, which opened up an entirely new field; this has been, and is being, actively explored in many countries from the time the German work was made public after the war. The chief members of this group are the original TEPP (HETP), sulfotep, schradan, parathion, methyl parathion, dimefox, demeton and methyl demeton. All are poisonous, to a greater or lesser degree, through their inhibition of cholinesterase activity and are subject to statutory control in use. The least toxic, and therefore of wider usefulness, is malathion, discovered in 1950 by the American Cyanamid Co.

Weed control chemicals

Modern methods of weed control can be said to date from work carried out from 1940 onwards by Imperial Chemical Industries Ltd. and from 1942 in America, which led to the development and rapid, extensive use of *MCPA* and *2,4-D* and their derivatives. Their selectivity of action and wide usefulness has completely changed the economics of agricultural crop production and has stimulated much research in the field of selective herbicides. Among later developments *MCPB* (1955), the carbamates (1945) and the *substituted ureas* (1951) are perhaps the most interesting.

Many chemicals have, perforce, been omitted from this brief survey; many fail to establish themselves in practice on economic or other grounds. But research continues, controlled only by its increasing complexity and the steeply mounting cost of its development and of biological and field testing, and toxicological and residue work. Its justification and the benefits it yields to the user of agricultural chemicals are reflected in the American statement that 80% to 90% of today's sales are in products which were not on the market 15 years ago.

Service to Agriculture

The Royal Agricultural Society of England's Research Medal has this year been awarded jointly to Dr. W. A. Sexton, F.R.I.C., and Dr. W. G. Templeman, M.Sc., of Imperial Chemical Industries Ltd. for their work in the development of modern selective weedkillers; they are the codiscoverers of the hormone (2, 4-D and MCPA) and carbamate weedkillers.

Crop Dusting in Difficult Country

R. A. LaJOIE
(U.S.A.)

IN four years Dave Bump, from Springville, New York, has crop dusted many farm areas throughout Colombia in South America and has become a master at shifting his sights from ground-level hedge-hopping to hazardous dives down steep mountain sides.

This type of flying is far removed from the simple crop dusting as performed by fliers in the U.S.A. and Canada, where farm areas are usually extensive, at low altitudes and more or less flat.

The mountainous terrain makes crop dusting no routine flying job. Farms may be at sea level in some places or on plateaux in the high Andes elsewhere. This flying fumigator may be dusting cotton or rice one day and the next skirting down the sides of the Andean hills, seeding new grazing areas for dairy and beef cattle or protecting the coffee and cacao ' fincas ' (plantations) against weeds and insect pests.

Top: *Diving under trees and skimming the tops of the young cotton plants in a plantation in Colombia*

Left: *A dramatic picture of a crop-seeding dive down a steep Andean hillside*

Farm Surpluses — Spectre or Salvation?

NORMAN MACDONALD

(*Special Report from Rome, Italy*)

In a starving world, American agriculture is drowning in seas of golden grain. The solution of this crazy unbalance could lead to a golden millenium; failure to solve the riddle of over-production and under-consumption could result in world-wide economic chaos.

THE 24-Nation Committee on Commodity Problems of the Food and Agriculture Organisation (FAO) has just concluded its 30th Session and issued its Report, which reveals that there has been a fall in the volume of world trade in agricultural products and a marked decline in prices, arising from the pressure of world supplies, principally grain, and this mainly in the U.S.A.

The Report adds:

'. . . important factors in the world situation are the consequences of a lack of co-ordination among diverse national agricultural policies, and the effect at the international level of the rigidity of certain national policies of price and income support. It was generally admitted that the increasing protection of domestic markets was largely responsible for present world difficulties, through stimulating surplus production. It was recognised that, from now on, the problem of surpluses should be considered as a permanent characteristic of world agricultural economy . . . '

Production and consumption

Efforts to solve the problems connected with the creation of agricultural surpluses and their disposal on a purely national basis are unsuccessful and are likely to continue to be so. The first principle of surplus disposal of FAO, however, appears to be irrefutable:

'The solution of the problems of agricultural surplus disposal should be sought . . . through efforts to increase consumption, rather than through measures to restrict supplies '.

The facts of surplus food production in one or more parts of the world and, at the same time, under-nourishment of two-thirds of the world's population can be related. If the right steps are taken, partial or complete solution of these inequalities can be of immense benefit, not only to world economy, but specifically to the U.S.A., which in the foreseeable future will be searching for vastly increased exports for her industrial products to replace the decreasing volume of agricultural commodities which will then be available for export.

The U.S. Administration should lend every assistance to efforts to build the agricultural and economic resources of the under-developed countries through international agencies, in her own long-term interests, even though for an appreciable time to come it may appear that her share of the financial burden in doing so is disproportionately high compared with the contributions of other, less financially strong participants in such efforts.

Self-made monster

American agriculture is overwhelmed with steadily increasing surpluses of commodities, principally grain – the U.S.A. and Canada together recorded the colossal surplus of 76 million tons in 1957. Yet across the oceans, in some Asian countries, hundreds of millions of unemployed landless rural workers fight the never-ending battle against starvation, not only for themselves today, but for countless generations to come. The world now adds to herself 100,000 human beings every 24 hours and, of these, 66,000 are doomed to pass their lives in semi-starvation or grave under-nourishment.

Both the American farmer and the Indian peasant are equally powerless to solve different aspects of the same problem – food – without substantial external aid. Thus in Iowa a farmer may burn his maize and, in face of the fact that two-thirds of the world's population is starving or insufficiently fed, this seems a sinful waste. But the fact is this farmer cannot sell his maize and he needs fuel. He cannot afford to buy fuel because he cannot sell his maize – so he burns his maize for fuel. It is as simple and yet as bafflingly complicated as that.

More hungry children

Human beings, by the mere fact that they are ***human***, cannot remain indifferent to the cries of hungry children and, in the world today, their voice is many hundreds of millions strong. In India alone five million new babies are born each year and, due to the triumphs of modern medicine, most of them survive, only to pass their lives in semi-starvation and to swell the multitudes of the hungry and diseased.

When the English clergyman, Robert Malthus, wrote his ideas about the limitation of natural human increase in 1798, world population was only 900 million. Now it is about 2,700 million, and experts agree that, by the end of this century, it will probably have reached at least 4,000 million, unless some unforseen disaster intervenes. Moreover, unless something is done about it on an international basis, an increasingly higher proportion of these people will only have enough food for a bare existence.

Humanitarianism and realism

A study of the results obtained through international action in using commodity surpluses, mainly grain, to build up the economic resources of these under-developed countries has indicated that this picture of seething hordes of semi-naked, starving people need not arise and that these same people could become potential buyers of consumer goods – in other words, they could provide a potential market for exporters of industrial goods of

unimagined scope – if the right steps were taken now.

On the other hand, the poverty of the under-developed countries is also increasing, more or less in proportion to the increase in population; unless such action is taken, the U.S.A. will not only fail to solve her agricultural surplus problems of today, but she will also have lost an immense potential export market for consumer goods of the future, so far as two-thirds or more of the world's population is concerned.

In other words, by A.D. 2000 some 1,800 million potentially 'live' customer accounts will remain dead. This is one occasion in world history when humanitarian principles of the highest order can mate with stark realism to produce hard cash dividends and a sound basis for future prosperity.

Cause of surpluses

Post-war surplus production in North America (including Canada) is due mainly to the fact that during the war years these two countries provided the principal source of bulk food supplies for Europe. At the end of the war, production per head of agricultural products was below pre-war, except in the U.S.A., where it had risen by 18%. For a number of reasons (including the war in Korea) demand continued at a high level in post-war years until the war-devastated countries had recovered their ability to produce for themselves, but North American agriculture still remained geared to this enormously increased demand. This varied by commodity, but applied most closely to wheat, of which North America accounted for three-quarters of world exports, as compared with only 35% before the war.

To achieve such a tremendous increase in a period of greatly increased domestic demand required the continuation of Government policies adopted during the war to encourage production. Through the U.S. Agricultural Act of 1949 and price support legislation, any switch to more flexible and lower support levels was postponed until the 1955 crop and thereafter.

Thus, while North American farmers maintained this enormously increased production, many of the countries which had relied on them for foodstuffs had not only regained their pre-war levels of production, but in many cases had surpassed them. In Western Europe, the biggest importers, the U.K., Western Germany and Italy, made special efforts to increase their production – the first two mainly for balance of payment reasons – and succeeded in bringing it to 35% above pre-war, thereby reducing their imports by 25%. France, from being a large importer of wheat, became a net exporter. Added to this, of the two main wheat-exporting countries outside North America – Australia and Argentina – the former had regained her pre-war production by 1947.

Decline in consumption

Other factors have contributed towards the creation of surpluses in the U.S.A., such as a decline in consumption of bread as income levels rose. The consumption of bread by civilians declined from 157 lb. per head of population in 1935-39 to 122 lb. in 1955, equivalent to 94.5 million bushels of wheat per year. In curious contrast, there is still an unsatisfied demand in the low income groups. Studies reveal that consumption of flour could be increased by 22–23% if the income level in the lowest family group could be raised from $2,000 to $2,500 yearly. In 1954, in spite of steadily increasing average income levels, there were still 5.9 million U.S. families in this category.

Efforts to eliminate surpluses

Surplus production in the U.S.A. has become a Frankenstein monster with apparently a vitality of its own which is superior to all efforts to control it. If temporarily suppressed in one crop or commodity, it springs up, stronger than ever, in another.

In one way or another, agricultural surpluses are costing the U.S.A. the vast sum of $10 million a day. This is a figure which even the U.S.A. cannot afford to spend from revenue without its effects being felt markedly in costs of living and production.

Recent agricultural policy has been aimed at avoiding the continuance of excess production, while maintaining farm income levels and reducing surplus stocks, but these measures have had only limited success. The measures introduced for restraining output by retiring land from production through the operation of the Soil Bank and through acreage restrictions did not work at all.

The total cost in 1957 for acreage reserve agreements paid to 910,000 farmers and for conservation reserve contracts paid to 85,000 farmers amounted to the colossal figure of $722 million; yet, although 27.8 million acres of the five basic crops was taken out of production, the farmers harvested a total crop which was 106% of the 1947–49 average and equalled both the 1948 and 1956 record crops.

The retired land was mainly in drought-subject areas and poor soils and, by cultivating their remaining areas more intensively, average yields for wheat were increased from 20.2 to 21.7 bushels, and for maize from 45 to 46.8 bushels per acre, compared with 1956.

Failure

The efforts of the Administration to cope with commodity surplus problems have been many-sided. In objective analysis, however, too many of the measures have been short-term and short-sighted, and the same problems are likely to face U.S. agriculture anew, unless far greater impetus is given now to measures which have hitherto received relatively little attention.

Price-support reserves of commodities amounted to $7,000 million at the beginning of 1958, which is $1,000 million less than the year before, but only because the Department of Agriculture was able to dispose of surpluses worth $5,000 million at home and overseas. The true situation thus is that residual surpluses increased during the period by $4,000 million, and, according to the Report, it appears unlikely that it will be possible to sell as much grain during 1958 as in 1957.

The present picture, therefore, is that, in spite of all the Administration can do, grain surpluses continue to augment and are, at the moment, out of control. The 1957 record surplus is expected to be exceeded this year, after allowing for the most liberal stockpiling and notwithstanding surplus disposals effected by the Commodity Credit Corporation (C.C.C.) under the authority given by the Agricultural Trade and Assistance Act of 1951 (P.L. 480), which has been increased to a total of $4,800 million. The success or otherwise of these disposal projects will become known when the report on operations under the present

authority, which expired 30 June, has been released.

So far as farm income levels are concerned, and in spite of President Eisenhower's statement in his farm message that levels had been maintained for the past two years, the facts published by the U.S. Department of Agriculture reveal that net farm incomes declined from $12.1 billion to $11.9 billion in 1957, or 1.6%, due to increased costs of living and production. This should be read with the President's statement that:

> 'The key problems remain unsolved. Rising production costs continue to limit farm incomes . . . acreage controls have failed to bring production into line and . . . unrealistic price support laws result . . . in loss of market'.

The problem today

According to Prof. L. Dudley Stamp, formerly of the London School of Economics, who is conducting the land-use survey for the International Geographical Union, the population of the U.S.A., at its present rate of increases of 3½ million yearly, will have passed the 300 million mark by 2000 A.D. – a little over 40 years from now. By then, he suggests, the U.S. will use all the food she produces for her own population and will have none to spare, and he predicts that either the standard of living will have to be lowered, or else foodstuffs will have to be imported. If he is correct, the situation in U.K., already short of cultivable land and who now imports 40% of her food requirements, will indeed be grave (see WORLD CROPS, 1958, **10,** 123).

He further states that, if the world goes on increasing in population at its present rate, there will be *standing room only* within a measurable period of time. He points to Japan, who, by using all ingenuity known to man, barely succeeds in feeding her *present* population on one-fifth of an acre per head (all the land available), together with the harvests taken from the sea in fish and marine vegetation. The Japanese produce 2,000 calories per head of present population, as against the S.N.U. basis of 2,460 calories.

This he sees as the picture of what the state of the world will be, as of the 13½ acres per head of the present population only 4½ acres per head can be cultivated – the rest is too arid, too cold, too mountainous or devoid of soil. As experts agree that 1 acre per head of population under cultivation by present population standards is necessary to produce the Standard Nutrition Unit needed for maintenance of health of American and Northern European physical types, this acreage shows the total margin for future development – according to his calculations. Supporting his predictions is the fact that, since Malthus made his prophecies, the world has trebled its population – that is, in 160 years – so that the margin for expansion of population is slim.

Such predictions, other experts point out, do not take into account the fantastic progress which agriculture is making by producing more and still more from the same superficial area. In India, for example, trials have shown that merely by the application of 15 lb. of fertilisers per acre the yield of rice could be increased by 10 million tons. In Egypt hybrid rice, introduced with FAO assistance, has increased the *average* yield per acre by 48%. Examples of this sort are too numerous to list. What is, however, certain is that there is a rapidly increasing disparity in numbers and resources between the 'haves' and 'have-nots' in terms of food and possibilities for food production.

The solution

After reviewing the evidence, it seems possible for the U.S.A., together with other exporters of consumer goods, to concentrate their energies on the economic development of the over-populated and under-developed countries (the two terms are not always synonymous – *e.g.* Japan, already very much over-populated, whose agricultural efficiency is rated as eight times that of U.K., 20 times that of the U.S.A.).

The purpose is to make them self-supporting and able to cope with progressive problems of feeding themselves as their populations, mount, double and redouble. If they can be brought to this state, then the prosperity of the U.S.A. and of the world can be assured for at least a reasonable period of time.

It would also appear from the Report that this result could be obtained by making use of the machinery of international organisations which have been proposed, but not yet brought into being, such as the World Food Capital Fund and the Special United Nations Fund for Economic Development.

It is, however, not by directly giving food to under-fed populations that any lasting benefit is achieved. This will strangle their agricultural production. It is only by building up the possibilities of each needy country to produce its own food supplies under properly controlled and regulated plans for economic development that poverty can be replaced by plenty, or at least by sufficiency. This can be achieved by implementation of the 'Capital through Food' principle, which has been employed in India with remarkable success in pilot schemes, but their scope has been limited because of lack of FAO funds. While finances may be sufficient for one such project, the work could be increased five-hundred-fold, if funds were made available.

Thus the paradox now exists of the U.S.A. spending billions of dollars on restrictive and profitless price support projects while paralysing by 'shoe-string' finance, the activity of the one organisation which could put into effect planned development and could also absorb agricultural surpluses and materially contribute to a healthy agricultural economy in the United States while, incidentally, assuring vastly increased markets for her industrial products.

Objectors to disproportionate financial participation by the U.S.A., compared with that of other traditional exporters of commodities, should reflect that not one of these other countries has as much at stake as the U.S.A., nor does any one of them have anything approaching the same potential for industrial expansion and the resulting need for export markets for industrial products.

Capital through food

The main cause of malnutrition is poverty – of the individual and of the nation – this applies all through the under-developed countries. We think of India as being over-populated and overcrowded with 370 millions, but the truth is that, of the potential agricultural land available, only half is used, because development projects cannot be financed. Of the total population, 70% or 260 millions are classed as rural workers, and the vast majority of these are under-fed because of their own poverty. Even when food is available they have no money to buy it. Yet, if India's potentialities for

production could be fully developed, she could not only produce enough food for all her people, but also have surpluses for export.

Basic requirements for aid

India, in fact, presents an ideal example of what FAO recognises as the basic requirements for the development of economic resources through food. These are:

1. There must be a reservoir of unemployed who could work if other facilities were available.

2. There must be lack of financial resources for wage payments.

3. The unemployed must be very poor. Their standards must be so low that their main concern is to have enough food and not consumer goods.

4. The projects upon which they are employed must require a high percentage of manual labour.

National poverty also means poor administrative services and this holds good in all the under-fed countries. Therefore, before deciding upon what projects for economic development can be undertaken, experts need to be supplied from outside in most cases. These are made available through the Expanded Technical Assistance Programme, which again, paradoxically, has had to face *reduced* financial contributions, as compared with the *increasingly* astronomical expenditure on price support programmes in the U.S.A. designed to control U.S. surlous production.

A technical development fund

Nevertheless, it is through an extension of one phase of the Commodity Credit Corporation's application of the authority granted to it under Public Law 480 that there appears to lie the greatest hope for a rapid increase in the volume of surpluses which can be channelled into the economic development of the under-developed countries. This depends, however, on farsighted members of the Administration lending their support to the proposals already under discussion by UNO for the creation of a Technical Development Fund of up to $100 million yearly, which could be used as a prelude to an international fund for capital investment. This fund would provide the means for the implementation of technically approved schemes in the under-developed countries.

Coming Events

Weeds and Weed Control. — The Fourth British Weed Conference will take place at Brighton from 3-6 November. It is organised jointly by the Society of Chemical Industry (14 Belgrave Square, London, S.W.1) and the British Weed Control Council (61 Curzon Street, London, W.1). Enquiries with respect to the papers presented at the conference should be addressed to the sessional organisers named below.

The provisional programme is:

TUESDAY, 4 NOVEMBER

MORNING

Opening address by the President of the British Weed Control Council.
Lecture – *A Survey of International Progress in Chemical Weed Control* (Dr. E. K. Woodford).
Papers – *Grassland Weeds.*
Session Organiser – Mr. G. P. Hughes, National Agricultural Advisory Service, Anstey Hall, Trumpington, Cambridge.

AFTERNOON

Papers – *Weeds of Cereals.*
Session Organiser – Mr. C. V. Dadd, National Agricultural Advisory Service, Anstey Hall, Trumpington, Cambridge.

WEDNESDAY, 5 NOVEMBER

MORNING

Lecture – *Herbicides and the American Farmer* (Mr. R. Beattey).
Papers – *Weeds of Horticultural Crops.*
Session Organiser – Mr. H. A. Roberts, National Vegetable Research Station, Wellesbourne, Warwickshire.

AFTERNOON

Papers – *Weeds of Arable Crops other than Cereals.*
Session Organiser – To be arranged. Enquiries to Mr. K. Wilson Jones, M.A., Tropical Products Institute, 56–62 Grays Inn Road, W.C.1.
Papers – *Special Weed Problems.*
Session Organiser – Mr. J. D. Fryer, Agricultural Research Council, Unit of Experimental Agronomy, University of Oxford.

THURSDAY, 6 NOVEMBER

MORNING

Lecture – *Weed Problems of Tropical Countries.*
Papers – *New Herbicides.*
Session Organiser – Dr. K. Holly, Agricultural Research Council, Unit of Experimental Agronomy, University of Oxford.

AFTERNOON

Papers – *Weed Control on Non-Agricultural Land and in Water.*
Session Organiser – Mr. S. A. Evans, Agricultural Research Council, Unit of Experimental Agronomy, University of Oxford.
British Weed Control Council Business Meeting.

Seed Production. – A Herbage Seed Production Conference, organised by the National Institute of Agricultural Botany, will take place on 18 November at Cambridge, England.

Agriculture.—Meeting of the European Confederation of Agriculture at Vienna from 20–23 November. Information from M. H. Abegg, Confederation Européenne de l'Agriculture, Brugg, Switzerland.

Botany.—The Fourth Latin American Conference of Plant Specialists will be held from 24 November – 6 December at Santiago, Chile. Enquiries to Dr. Rene Cortazar, Departmento de Investigaciones Agricolas, Ministerio de Agricultura, Casilla 4088, Santiago, Chile.

Cottonseed. – A symposium on 'Cottonseed and its By-products' will be held in Hyderabad from 5–7 December. Discussions will cover the processing and storage of cottonseed, refining of cottonseed oil, hydrogenation, solvent extraction, fundamental studies, by-products, standards, statistics and marketing data. Enquiries to the Director, Regional Research Laboratory, Hyderabad–9, India.

Smithfield Show. – The Smithfield Show and Agricultural Machinery Exhibition will be held this year from 8–12 December.

Farm equipment.—The Farm and Industrial Equipment Trade Show takes place from 28–31 January, 1959, in Toronto. Information from Canada Farm and Industrial Equipment Trade Show Ltd., 40 Wellesley Street East, Toronto 5, Ontario.

Agricultural machinery.—The 30th Salon Internationale de la Machine Agricole will take place from 3-8 March, 1959 at the Exhibition Ground of 'La Porte de Versailles' in Paris. Information from L' Union des Exposants de Machines et D' Outillage Agricoles, 95, Rue Saint-Lazare, Paris (9), France.

An immense swarm of red locusts crossing the edge of the north Rukwa outbreak area Photo: Vesey-Fitzgerald

Control of Red Locust

Recent Developments in the Application of Insecticides

J. H. LLOYD*
(*Chesterford Park Research Station*)

The author discusses the advantages of using aircraft over land vehicles and other ground control methods for the destruction of swarms of adult locusts prior to migration

THE last great red locust plague lasted from 1929 to 1944 and at its peak the invasion extended over three million square miles of southern Africa. Incalculable damage was caused to crops and grazing, and much effort and money had to be spent on locust destruction. The invasion could not be checked because of its great size and, though measures were organised for the direct defence of crops, they were not always adequate because there were no effective methods then available for attacking adult locusts (fliers) and practically all the control effort was directed against hoppers (nymphs).

The origin of the plague was traced to small flood-plain grasslands around Lake Mweruwa Ntipa in Northern Rhodesia and in the Rukwa Valley in Tanganyika Territory. These places are now known certainly to be the principal outbreak areas and, though the Malagarasi Region also produces swarms occasionally, it has seemed so far to be less important. The discovery of the outbreak areas led to the hope that it might be feasible to prevent red locust plagues at a low annual cost by suppressing the pest at its source, and, to effect this, the International Red Locust Control Service was established in 1941.

* Formerly of the International Red Locust Control Service, Abercorn, N. Rhodesia

Control policy

There are few factual data about the swarms that escaped from the outbreak areas to initiate the last plague. It seemed, however, that they were few in number, which implied that suppression of the red locust has to be completely effective for plague prevention to be assured. That is to say, scouting and control methods are required that can prevent the escape of even a single swarm. This degree of perfection could not be reached readily, for the outbreak areas are nearly 2,000 square miles in extent. Owing to difficulties of terrain and of locust

Photo: Gunn

An escaped swarm of red locusts roosting in the trees on the Ufipa Plateau, Tanganyika Territory

mobility, there have been numerous problems encountered in developing scouting of the intensity and accuracy required and control methods that are powerful enough.

Over the years, notable successes have been scored against upsurges, but there have been occasional swarm escapes, though none have occurred since 1954. Fortunately, no plague resulted from these escapes, but there was some concern, for it was felt that the Service might be failing in its object, and it was costing rather more than had been expected. This was due partly to the high costs of mechanisation and roads development, and partly because of the control policy.

The practice was to attack non-swarming infestations of hoppers and adults by round-the-year control in order to keep the over-all population at a low, safe level, for it was known that the ground methods in use might not be powerful enough to deal with a serious upsurge once it was under way. Consequently, control costs were high because extensive areas of safe infestations had to be attacked. There were indications also that methods in use were not operated efficiently and following a suggestion made by Dr. D. L. Gunn, full-time operational research on control was begun in 1952.

Hopper control

The locust-breeding season is relatively short and starts at the onset of the rainy season in November. The hoppers produced are usually scattered widely and occur in dense groups or bands that may often be little more than 1 sq. yd. in extent. There may be many thousands of these tiny targets totalling millions of individuals that have to be found and destroyed. The hoppers are small and difficult to see in the tall grass of the outbreak areas, so that intensive searching for control is necessary. As a result of flooding, much of the terrain may be impassable to wheeled and even tracked vehicles, and the control system which had been evolved was to use men for hand methods on wet ground and machines where it was dry.

The insecticide used was 6% gamma benzene hexachloride (BHC) in a wettable powder formulation, which was applied in aqueous suspension by hand pumps and as the powder by power dusters. Hand dusting was not then used to any extent because it was too extravagant in insecticide.

The extent to which these methods might supplement each other was governed by an unpredictable course of flooding. There seemed to be a possible danger that if, due to flooding, machines could not be used at all in a badly infested region there might be too large an area left for the hand-spraying teams to deal with. Moreover, it was known that the scouting and reporting system, then used for hoppers, was so inadequate that there might be little warning of a situation having got out of hand until the adult locusts appeared in overwhelming numbers. Clearly, it was vital to know the performances of all the methods in use so as to find out how they might be combined most effectively and economically to deal with the worst situations.

Use of ground sprayers

Detailed observations of the methods produced some interesting results. Hand dusting was the most generally applicable method and it was both cheaper and faster than hand spraying and power dusting, though it did use rather more insecticide. It seemed, indeed, that hand dusting was suitable enough to replace the other methods altogether, and it had the advantage that hoppers were found and destroyed at the same time, so that it was not dependent on a scouting and reporting system for locating hoppers for control. It had been found, also, that the first and second instar hoppers could be controlled successfully with an area dosage of 3 lb./acre of 6% gamma BHC powder, but as the hoppers grew the area dosage had to be greatly increased and amounts as much as

70 lb./acre of the material failed to give complete control of fifth and sixth instar hoppers.

It was advisable, therefore, to control the hoppers in their early growth, so that the insecticide could be used most effectively and cheaply. It was decided to try hand dusting in large-scale operations without other methods and the aim was to comb the plains speedily so that the dense infestations could be killed while the hoppers were most susceptible to the insecticide. In order to keep the poison application rates down, cheap and simple bellows dusters that could be operated by one hand were chosen for use. This method was called puffer dusting.

The technique worked very well, but it was not good enough, for in two areas there were subsequently swarms of fliers on such a large scale that ground sprayers were overwhelmed. There seemed to be little hope of finding a more effective ground method and, though an improvement was obviously needed, its importance diminished with the replacement of ground sprayers for attacking fliers by more powerful aerial spraying methods.

Use of aircraft

Investigations on methods of controlling hoppers by aircraft were then begun and one that has shown promise on a small scale is lattice spraying, using a persistent stomach poison. The insecticide used is dieldrin applied at a rate of 4–5 oz./acre in 1½–2 gal./acre of aqueous emulsion. The sprayed swaths are 20 yd. wide and they are spaced in such a way that a high proportion of the hoppers in the unsprayed gaps of the lattice will, in the course of their migration, encounter one of the sprayed strips and eat a fatal quantity of poisoned grass.

The insecticide persists for three weeks and, since the bands move about a great deal in this time, the spacings of the lattice can be made fairly large. Aerial reconnaissances for hoppers have also shown that bands are sometimes visible from the air and it is thought that they might serve to show relative extents of infestations so that areas can be chosen for lattice spraying without detailed ground aid.

Adult locust control

Adult locusts are difficult to attack because they are so very active and mobile. The first successful control of red locust fliers was scored in 1947 by aerial spraying attacks on settled swarms in Rukwa. A specially developed solution of 20% dinitro-*ortho*-cresol (DNC) in oil, applied at an average rate of 1 gal./acre from Avro 'Anson' aircraft, killed the locusts quickly and effectively and an extensive area was cleared of swarms. The swarms remained settled for only a short time after daybreak, so spraying had to be done speedily for complete coverage of swarms before they started flying; the rate of aerial spraying was actually 45 acres per operational hour, which does not include time on the ground between sorties. Though control was highly effective, the method seemed to be too expensive for routine preventive control.

Use of ground machines

The suggestion then made was to develop for the Service powerful low-volume drift-spraying ground machines that could work as fast and effectively as aircraft, but at rather less cost.

The 'Airflow' prototype ground machine, then designed by Dr. H. G. H. Kearns, proved to be quite powerful and was used successfully in many control operations. Excellent locust mortalities were obtained by spraying 20% DNC at a rate of 1 gal./acre, using swaths 180 yd. wide. The machine could spray 30 acres of locusts per operational hour, which includes time for travelling, insecticide filling and other activities.

A similar type of commercial machine, the Drake & Fletcher 'Mist-ejecta', which was much lighter, had the same performance. These machines had to be used at night, for they did not have the range of speed to attack locusts in the daytime. They were not so fast in action as the Anson aircraft, but one machine could spray a larger area during a night than one aircraft could in the short time available for spraying settled swarms in the daytime. The airflow-type machines were five to 10 times faster than the lance-sprayers and medium-volume machines that had previously been relied on and they were also more efficient because they did not depend on large supplies of water for insecticide dilution.

The disadvantages of ground machines in general were that they could not be used on wet or very rough terrain at the end of the rainy season, when heavy infestations are liable to occur.

In 1954, however, the drift-sprayers failed in use against a heavy upsurge due to the absence of steady winds suitable for spraying. This was unusual, but a similar condition prevailed in the dry season of 1945, which was also an arid year in the Rukwa, and during which 50–100 swarms emigrated from the outbreak areas. It seemed that drift-sprayers were impracticable if aridity is associated not

Photo: Fed. Inf. Dept., N. Rhodesia

An airstrip can easily be prepared on the flat plain of the Rukwa Valley by simply mowing the grass. A Piper PA-18A '135' aircraft is seen taking in fuel and insecticide

only with red locust upsurges, but also with an absence of winds, suitable for spraying wide swaths.

Use of light aircraft

The machines that had to be used instead of the drift-sprayers could not suppress the upsurge, and the aid of light spraying aircraft was sought. Two Auster J5/G aircraft, lent by Desert Locust Control, arrived quickly and destroyed a swarm that escaped from the North Rukwa outbreak area. Aerial spraying operations were then continued in this region and within a short time the situation was temporarily brought under control. The high striking power of the aircraft was evident and when swarm activity flared up again later in the year, aircraft were used instead of ground machines, and there were no further swarm escapes.

The performance of aerial spraying was worked out in detail during these operations. The aircraft used were Auster J5/G and Piper PA-18A '135' types, fitted with boom-and-nozzle spray gear. These machines had a similar spraying performance and their average rate of spraying was 66 acres an operational hour. The aircraft were operated from airstrips made by mowing the grass on smooth parts of the plains that were near enough to the infestations to ensure a high speed of attack.

The aircraft were 10–20 times faster in action than the medium-volume ground machines and more than twice as fast as the drift-sprayers. Moreover, the aircraft were effective in attacking flying swarms so that aerial spraying could be kept up through the daytime and, because of their speed and mobility, the aircraft could, in a day, attack several large swarms spread widely apart. The aircraft were useful for reconnaissance also, as dense swarms of settled and flying locusts could be found from the air without ground aid, so that the risk of swarms escaping unnoticed was greatly reduced.

The cost of using chartered aircraft to control an acre of locusts was nearly 20% less than that of using ground machines and had the aircraft been utilised to their full extent they would have been even more economical. Clearly aircraft were required, for ground machines were unsuitable however much they might be increased in numbers. The decision was then made to adopt light aircraft for control and work was begun on the construction of all-weather airfields at the edges of the outbreak areas. It was evident that the conclusions reached from the use of larger aircraft in 1947 had been much affected by differences in type of aircraft and methods of utilisation.

The change-over to aircraft was timely, for in 1955 there was a tremendous upsurge of locusts in Rukwa.

Photo: Lloyd

A red locust swarm in the north Rukwa outbreak area being sprayed by an Auster 5/GJ aircraft

It was the largest which has ever been recorded in any detail and virtually all the control done during the year was by chartered Piper PA-18A aircraft; not a single swarm escaped. During the campaign nearly 50,000 gal. of insecticide were sprayed on roughly 50,000 acres of swarms, containing of the order of 1,500 million locusts. The cost of chartered aircraft and insecticide to control an acre of locusts was nearly 16*s*., or little more than half the cost of ground sprayers used in 1954. The success of these operations amply confirmed that control effectiveness and economy had been greatly improved, for the same results could never have been achieved by ground methods.

Photo: Gunn

A red locust roosting site in the north Rukwa outbreak area, showing the height and density of the grass

Changes in policy

The Service now owns two Piper PA-18A aircraft and their high striking power has resulted in a new control policy – allowing the concentration of locusts into swarms to proceed a long way, and destroying them when they are about to migrate. This has spared the Service the cost of attacking larger areas of lower density infestations. The speed and mobility of aircraft have also removed the need for maintaining so many bases in the outbreak areas and this has resulted in savings in manpower, machinery and administration. The cost has been reduced to about £200,000 a year, and such data as there are, of costs and damage due to previous invasions, suggest that this is a reasonable price for the successful prevention of red locust plagues.

There have been important developments in methods of forecasting and population assessment, and in non-chemical control, which greatly aid the effectiveness of control. It seems likely that, with further developments in hopper control by aircraft, complete control can certainly be achieved.

Mechanisation in Britain

According to the U.K. Ministry of Agriculture, Fisheries and Food, the latest census figures suggest, for the first time, that farmers' holdings of many items of machinery are now fully adequate and that the future intake of new agricultural machines will be confined to those required for the replacement of worn-out machines or to new designs, offering a better product or more economy in time and labour. These machines include wheeled tractors and fertiliser distributors and all forms of transport, tractor ploughs and other cultivating implements, corn and combined drills, mowers, binders and other hay-making implements.

This news emphasises the urgent need to develop overseas markets for agricultural machinery and equipment for which there is an enormous potential demand, exceeding by a hundred times the replacement and renewal requirements of Britain.

Gibberellic Acid

The New Plant Growth Regulator

D. P. HOPKINS, B.SC., F.R.I.C.

During the past year there has been a tendency to exaggerate the possibilities of this new plant regulator. In this article the author gives the history of its discovery and development and places the matter in its correct perspective.

IT would be wrong to regard gibberellic acid as a suddenly discovered 'nine-days-wonder'. Its arrival as a potential plant-growth stimulator was, in fact, far from sudden. Japanese research from 1926 to 1939 had taken the gibberellin story to quite an advanced stage. A rice disease, one symptom of which was the exceptionally tall growth of infected seedlings, was found in 1926 by Kurosawa to be caused by a soil-borne fungus, *Gibberella ujikuroi*.

By 1939, other Japanese workers had isolated an active, crystalline substance from culture filtrates of this fungus, and they called this substance 'gibberellin A'. There is a gap in the sequence of events until approximately the 1950s, when I.C.I. research in Britain and independent research in the U.S.A. both isolated a purer substance from cultures of this fungus. The British isolate was identified as gibberellic acid, and the U.S. isolate, at first called 'giberellin X', was later proved to be gibberellic acid.

Recent interest

The recent revival of interest in the products of *Gibberella fujikuroi* was not concerned with disease-causing effects on rice, but with the possibility that the plant-enlarging property could have useful applications. One American commentator has said that in the summer of 1957 as many research man-hours were devoted to the effects of gibberellic acid on plants as were totally spent upon 2,4-D in its first two years.

This delayed interest in a substance which was known before the war is understandable, because there has been enormous development since 1939 in techniques for the production of biologically-active substances from mass cultures of fungi; there have also been tremendous advances in the application of substances that promote or influence plant growth.

Nature of the product

The acid itself has proved to be the extractable substance – a white crystalline solid, $C_{19}H_{22}O_6$ – moderately soluble in water and highly active in a concentration range of 1 to 300 parts per million. Solutions in water, or in water/alcohol mixtures, are not very stable, but little of the activity is lost within 24 hours of making up such solutions.

Applications to plants seem best made by spraying, though micro-applications as a dust or paste are also given; applications to the soil are much less effective, as gibberellic acid is fairly quickly decomposed in soils.

Still under trial

Some firms are already marketing gibberellic acid, but as a product for growers or gardeners to test or experiment with, rather than as a product with specific crop uses. Most producers have wisely refrained from sales-pressure campaigning; a leading British company has merely made it known that supplies are available for research workers. Against an occasional tendency for the press to write wildly about 12-ft. tall cabbages or giant beanstalks that hitherto have appeared only on the pantomime stage, this restrained approach towards marketing gibberellic acid must be commended, but it is no more than common sense.

In the long run it is against the interests of any reputable company selling a range of chemicals with established farm or horticultural uses to seek temporary trade for a new substance whose benefits are still highly problematic. Indeed, the big question is whether soundly economic uses for farm or garden crops can be developed, or whether one day most of the research files will close upon a passing curiosity that merely stimulated freak, but unuseful, growth.

The effect of gibberellic acid on a geranium. Left: *Treated plant.* Right: *Untreated plant*

Growth stimulation

The gibberellic acid effect that has the most obvious potential value is the elongation produced in the stems and leaf stalks of many kinds of plants. This effect is usually more pronounced with dwarf varieties than with normal plants, *e.g.* with bush roses and dwarf beans. At first thought, here is a *quantitative* benefit – bigger plants should produce larger yields. A recent British paper (D. G. Morgan and G. C. Mees, *Journal of Agricultural Science*, 1958, **50**, 49–59) has shown how illusory this assumption is. Tests of gibberellic acid, principally on grass, but also on a variety of crop plants (wheat, potatoes, turnips, carrots, peas, runner beans, lettuce, celery, blackcurrants, kale and maize), are described.

Grass, it would seem, is an ideal crop for studying a stem- and stalk-enlarging substance. It was, indeed, found that treatment by spraying led to increased yields of grass in the earlier spring or in the autumn, *i.e.* at periods when the natural growth rate is slow. These increased yields could be produced more speedily than through the application of fertilisers,

though in amount the increases were not bigger than those obtainable from only very moderate rates of fertiliser. The extra growth of grass due to the gibberellin was independent of any fertiliser effect also producing extra growth.

However, it was a less lasting increase in growth than that obtainable with fertilisers, and it led to lower protein contents in the grass. Furthermore, if the extra yield of grass from gibberellic acid treatment was taken by cutting, the yield from the next cut was reduced by about the same weight as that of the first cut's increase, though this could be prevented by giving a second spraying with the acid after the first cut.

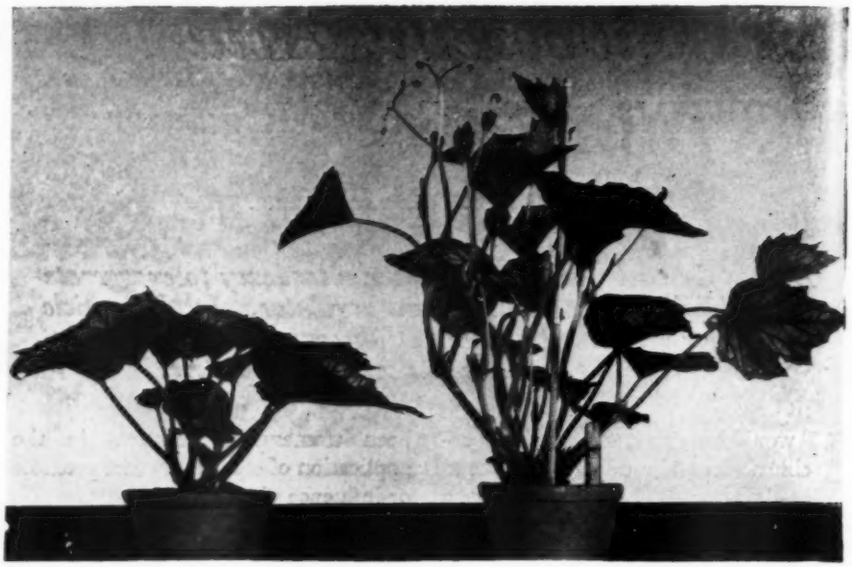
This might suggest that repeated sprayings after each cut could maintain the yield benefits of gibberellic acid, but it was found that these frequent treatments led to a thinning of the grass sward. These rather discouraging results emerged from trials over three years at four different grass centres and the findings did not differ appreciably at any centre.

The conclusion was reached, therefore, that ' the acid has no advantage over a fertiliser application for increasing the growth of grass, except in the spring or autumn, when the action of fertilisers was slow '. Possible advantages might be the increase in output for early spring or autumn grass, but ' reductions of yield that follow later are important objections to its use even in this way '.

No yield increase

The same paper reported that, although wheat treated with the acid showed stimulated growth for a time, no increase in straw or grain yield was obtained at harvest. The vegetative growth of most of the other crop plants treated was similarly stimulated for a time, but ' in no case was the crop yield increased ' and the yields of potatoes and carrots were actually decreased. A particularly negative statement in the discussion is that ' it seems from this work unlikely that gibberellic acid will find a use as a growth stimulator in agriculture ', though the qualification is added that crops grown for foliage, like grass, may be exceptions. However, the work on grass seems to have removed much of the hope from this proviso.

It may be premature to write off direct yield-gain effects, and certainly this should not be done on the results of one research study in a single country. It can be assumed, however, that any case for gibberellic acid as a direct yield-raising application will be difficult to establish, especially under economic assessment. Even if some specific yield-increasing effect seems promising under certain conditions, the value of the crop gain must be emphatically greater than the cost of the acid and the spraying operation.



Photos: Plant Protection Ltd.

The effect of gibberellic acid on the begonia. Left: *Untreated plant.* Right: *Treated plant*

Longer fibres

But stem and stalk elongation is not the only consideration. It has been suggested in the U.S.A. that cotton crops may benefit through the production of longer fibres, and so command a higher price; one does not know how far this is speculation or how much evidence points towards a practical possibility.

In the horticultural field it has also been suggested that certain flowers, *e.g.* roses, might fetch higher prices if grown with longer stems. In short, if the elongation effect can increase market value through ' shape ' of crop product rather than weight of output, direct benefits from the elongation effect may yet result.

Early flowering

Gibberellic acid has other effects on plant growth. Though less obvious and plant-universal than elongation, these could well prove to have greater importance. At least two effects upon flowering have been observed – the promotion of earlier flowering, *e.g.* tomatoes (many fruit subsequently formed being seedless), and the induction of flowering in biennials without the exposure to a period of cold usually required, *e.g.* petunias, stocks, pansies etc. For this effect there would certainly seem hopeful possibilities More generally, earlier flowering may be well worth the costs of such treatment if better prices are secured for still earlier out-of-season flowers.

Earlier flowering may also be of benefit for seed production, whether flower seed or vegetable seed etc. When gibberellic acid induces earlier flowering it has generally been found that flowers and seed are normal. Times required for variety breeding could be reduced by the intervention of gibberellic acid, although with some plants flowering is delayed and not accelerated.

Nor is this prospect confined to ornamental plants; U.S. work with bean crops and broccoli has shown that the hastening of flowering leads to earlier maturing of the crop; with broccoli, production of marketable heads was advanced both in the open and under glass by 10 to 15 days. In suitable market circumstances this can make a very big difference to the price of broccoli heads.

Breaking seed dormancy

Another effect is the breaking of seed

dormancy. This has not been as widely observed, but for some kinds of seed gibberellic acid induces more rapid germination. Lettuce seed, which need a red light exposure to stimulate germination, can be treated instead with the acid. The dormancy of bulbs, corms and tubers can also be broken by gibberellic acid.

In some cases of speeded germination the seedlings have suffered from undesirable elongation effects – but this could well be a matter of dosage, *e.g.* pea seeds soaked overnight in a 10 or 25 p.p.m. solution produced earlier, non-elongated seedlings, whereas pea seed, treated with a solution of 50 or more p.p.m., gave elongated seedlings.

Sprout stimulation

Whether the increased sprouting that is induced by soaking seed potatoes is as strong as normal sprouting also seems to need investigation. There is another interesting post - cropping benefit that may be capable of development – using it to break dormancy in recently harvested barley grain; if this could be developed, it would be of much advantage to maltsters.

Stimulation of new shoots has received attention. When citrus shoots can be expected to remain free from virus infection, they are still too small for successful propagation – but, with shoot growth accelerated by gibberellic acid, it may be feasible to take the cuttings before the risk of infection has been reached. Stem suckers of pineapple have been treated in the hope of increasing the number of developing buds they can produce.

Summary

A short summary cannot, of course, cover every kind of gibberellic acid effect or test; what has been mentioned is a simple review of the type of work so far carried out. If the over-obvious *quantitative* effect of larger crop yields has already failed its early promise, the various *qualitative* effects still offer possibilities of development.

Broadly, it might be said that the success of gibberellic acid treatments for crops will depend on indirect rather than direct consequences. One example is the production of seedless grapes in California; usually this is achieved by girdle-cutting the vine bark, an operation costly in labour – but it can also be achieved by gibberellic acid spraying; it has been reported already that the spray treatment is less costly than the manual method.

Conclusion

The commercial uses that may be developed in time can be expected to be specific to certain plants, perhaps even to certain varieties. Obviously a vast amount of trial-and-error research and practical testing is still required. Gibberellic acid is not cheap and until larger demand leads to higher production and lowered costs – the usual economic story of mass culture-produced substances – benefits worth the cost of treatment may be confined to high-value horticultural crops, though it can yet hardly be concluded that farm crops will never benefit from gibberellic acid.

(Gibberellic acid was discovered by a group of workers, working under Dr. W. P. Brian, at the Akers Research Laboratories of I.C.I. Ltd., and extensive fundamental work on its effects on plant growth was carried out there. Notable pioneer work was also done by Dr. S. H. Wittover, of Michigan State University, and by Dr. F. H. Stodob, of the U.S. Department of Agriculture. Development work continues at the Fernhurst Research Station of Plant Protection Ltd. and also at the Jealott's Hill Research Station. The product is now being manufactured by I.C.I. Ltd. and small quantities are available from Plant Protection Ltd. to scientific workers in the agricultural and horticultural fields. It is not yet being produced on a large scale. – Ed.)

Aerial Farming

Aerial top-dressing has made such advances in New Zealand in the past three years that it is now no longer correct to speak of aerial top-dressing, but rather to refer to aerial farming or agricultural aviation. The distribution of fertiliser continues to be by far the main activity of the industry, but supply dropping, seed sowing and crop spraying are all accounting for an increasing proportion of the hours flown annually by agricultural aircraft.

The primary importance of aerial farming to New Zealand's economy is obviously the part it is playing in increasing production of the country's principal exports.

There are other effects. It is, for instance, due to the enormous increase in top-dressing operations, made possible by aerial agriculture, that New Zealand's fertiliser manufacturing capacity is now being extended on a scale that never could have been imagined ten years ago. Important, too, has been the expansion of old-established industries that have found new customers in the numerous concerns that now specialise in aerial farming. The demand for agricultural tools and equipment, radio gear and components of various kinds has resulted in more work for New Zealand factories. In this way another close liaison has been effected between primaryand manufacturing industries.

Aerial Operations

According to *The Australian Producer*, more than 50 companies are licensed for aerial work, and there is a vigorous Aviation Industry Association in New Zealand.

For the year ended 31 March, 1957, 60 operators, using 262 planes, made 948,218 flights to spread 428,245 tons of fertiliser over 3,945,586 acres.

In the same period 408 tons of seed were sown in 14,393 flights over 68,238 acres; 4,239 tons of rabbit poison were spread in over 16,000 flights; 561,000 gal. of spray mixture were put out in 15,201 flights; and 719 tons of supplies (including fencing materials) were dropped.

Much of New Zealand pastureland is so hilly that top-dressing is only possible from the air, but aeroplanes are also being extensively used now for top-dressing even flat or gently undulating country.

Under normal conditions a top-dressing aircraft makes about 12 flights an hour, while some pilots have made up to 150 flights in one day.

The average duration of each flight would be about four minutes. Great speed has been attained in the turn-round of working aircraft. This takes under two minutes, in which time the plane has touched down, taxied to the loading point, taken on as much as a ton of superphosphate and become airborne again.

The average cost to the farmer of top-dressing was estimated to be in the vicinity of 35*s.* an acre.

Approximately £2 million has been spent by farmers on landing strips and facilities, and the aeroplane operators have made a capital outlay of about £1,300,000.

A Mechanical Water Buffalo

A unique crawler tractor developed by an international authority on land drainage.

The ' Water Buffalo ' in marshy ground

THE ' Water Buffalo ' has been described as ' one of the most interesting developments in tracklayer history, with a hill and bog performance which needs to be seen to be believed '. It is a striking example of man's achievement in the face of difficult conditions. It can, in fact, proceed where man dare not tread.

Preceding the birth of this tractor was the development by Mr. J. A. Cuthbertson, of Biggar – an international authority on land drainage – of drainage and turf-planting equipment primarily to advance agriculture and afforestation in remote and almost inaccessible parts of Scotland.

Whilst these were important steps in themselves, there remained the problem of finding for this equipment a prime mover capable of travelling over ground which could not support a man, still less a heavy vehicle. Different types of conventional tractor were tried, some even fitted with special wide tracks, but they were not successful. One weakness revealed by these tests was the high incidence of wear on the conventional pin and bush-type tracks.

So, out of necessity, was produced the prototype of what is now known as the ' Water Buffalo '. It had an oscillating undercarriage which allowed the track to follow the contour of the land and thus distributed the weight of the machine evenly over the surface on which it was travelling. A water-tight hull, in which all mechanical parts were enclosed, was also provided, and the pin-and-bush problem was overcome by designing a track made up of wire rope embedded in rubber.

Three models

Many improvements have since been made to this original design and the standard model has now three variations of track width. When equipped with 24-in. tracks the tractor has a ground pressure of 3.11 lb. per sq. in.; the ground pressure of the 36-in. track model is 2.26 lb. per sq. in.; and the fully-amphibious 8-tonner, having a 48-in. track, gives a ground pressure as low as 1.5 lb. per sq. in. Each of these versions can operate on ground conditions which would not support a man, whose average ground pressure is about 6.5 lb. per sq. in.

The ' Water Buffalo ' is, therefore, designed primarily for work on land conditions where no other form of vehicle would be able to operate, and yet on solid ground it can easily climb gradients of up to 1 in 1.

Other applications

Although the tractor has a very wide range of applications, the majority of those in service are being employed on the type of work for which it was originally designed – towing drainage ploughs. A light bulldozer blade has also been developed and is proving satisfactory for light levelling operations in very soft ground. With a drawbar pull of up to 20,000 lb. in certain conditions, the 36-in. track ' Water Buffalo ' can haul equipment capable of cutting deep drainage ditches in one operation.

In the Netherlands, the tractor has played an important part in reclaiming from the sea large areas of land which are being dammed and dried for cultivation. Waterlogged parts of East Africa, Falkland Islands, Newfoundland, Kenya, New Zealand, Eire, Sierra Leone, Malaya and Uganda have been turned into agricultural and grazing lands by this means. The forestry departments in Scotland and Sweden have used the ' Water Buffalo ' successfully for drainage and planting. The British Ministry of Works employ one to carry surveyors and their equipment across wide stretches of peat bog. Although this holds up to 10 people, it can still tow a large load in a tracked trailer.

Radar stations in Northern Canada are served by the ' Water Buffalo' for hauling sledges over hundreds of miles of peat bog. In many cases this is the only land vehicle able to reach the stations the whole year round, as no other machine is able to travel in these parts except when the ground is frozen. Its special rubber tracks are also more resistant to freezing-in than all-steel tracks, as they are flexible and break free of surface ice more readily than conventional designs.

Albion Motors Ltd. supply the power unit for the standard model – the EN.287 4-cylinder, direct-injection diesel engine, coupled with the Albion clutch and a 5-speed gearbox. Another version of the ' Water Buffalo ' for Canada is to have the Leyland EO.600 engine, developing 125 h.p., possibly with a fluid coupling and a pneumatically-controlled self-change box. This is intended for the rapid movement of men and materials and for prospecting and land drainage.

Biological Control using Ladybirds

J. B. KEMMERER
(*Los Angeles, U.S.A.*)

Ladybird, ladybird, fly away home,
Your house is on fire and your children alone!

THE Ladybird was so named during the Middle Ages, when her aphid-eating habits were already known and she was dedicated to the Virgin Mary as the ' Beetle of Our Lady '. The old nursery rhyme refers to the burning of the hop vines in late summer when the plants are thick with ladybirds.

A lack of balance is often to be found in field crops, because when the farmer sprays his crops to kill crop-consuming pests he also destroys the ladybirds which consume soft-bodied insects, such as aphids, mealy bugs, spider mites, scale insects and the eggs of these pests. After the spraying the aphids may return and as there is nothing to check them they may destroy an entire crop.

Right:
At certain times of the year the ladybirds migrate to the mountains and there hibernate until it gets too cold, after which they move down to the snowline. They swarm over stems and branches and cover rocks and stones in their millions

Below:
The small dark spot under the head of the ladybird (magnified many times) is an aphid. It will eat about 50 a day; it will lay about 200 eggs and, when hatched out, the young will eat a further 60

Migrations

It will be apparent that the successful use of ladybirds to control such pests will depend on their availability when they are most needed – mainly in the spring. This predator, however, migrates in late June or early July, when the lowland temperatures rise to over 95°F in the valleys of Southern Arizona, and they move up to the high mountains for the rest of the summer. This migration is not in swarms, but individually. A ladybird, consuming spider mites in a cotton patch or aphids in a lettuce field, will suddenly take off without warning. She will shoot up to about 200 or 300 ft., level off and soon be lost to sight, even with field glasses.

About this time, concentrations of ladybirds will begin to appear in the Mogollons Mountains at an elevation of 8,000 to 9,000 ft. At higher elevations than this, the air is too rarefied or too cold for them. Apparently the same resting places are used year after year. The ladybirds alight on bushes and accumulate until the branches are weighed down to the ground. They cover sticks, logs and even stones, fold their wings and sink into a semi-coma.

In September, when the temperature falls, they awake and move several thousand feet down the mountain to about the snow line and take shelter. They will crawl under logs, boulders, behind bark, or into any crevice that will afford them some protection, and they will hibernate there until the lowlands are once again warm and sunny and they can return.

It has been found that they swarm at different times in different localities. In California it is in late May and early June; in Arizona, in late June

and early July; in Idaho, in the early autumn and spring, and the same in Northern Utah. It is at these times that the collections are made.

Collection and storage

Wherever the collectors find a concentration they spread cellophane sheets over the ground and shake the beetles off the bushes. Cellophane is used because the beetles cannot obtain a footing on the smooth surface and they can be slid easily into buckets. In places they swarm in millions and may yield as much as 300 gal. to the acre.

The problem now is to keep them until the spring. This is done by placing them in cold storage at about 10° lower than atmospheric temperature, but never below 32° or above 60°F. The bags containing the insects are sprayed with water at 10-day intervals to compensate for the reduction in atmospheric humidity which occurs during cold storage. It is found that six months later 90% of them are still active and alive.

Packaging

The next problem is to pack them correctly for storage and shipping, for each beetle must have some sort of footing or they will pack together solid and die. They need to be kept in a cool place and must never be put near a hot pipe or a stove.

These ladybirds are very active, even though they have been in cold storage for several months

Formerly ladybirds were packed in cotton sacks filled with pine cones and the interstices of the cones offered the footing that each requires. Now the same result is obtained by the use of cardboard cartons filled with corrugated cardboard to provide the necessary surface area to give each insect its required footing. Consignments are either sent by post or by air mail, according to the distance.

Sale and utilisation

George Quick, of Phoenix, Arizona, who is organising these collections, has 10 people collecting for him all the year round and as many as twenty in the season, working on contract. Prices range from $7.50 to $15.00 per gal., and in a year he expects to sell about 15,000 gal. or 17 billion ladybirds for a gross return of about $175,000 (approx. £50,000) at the current price. A market gardener may order 25 gal. for his 25 acres of lettuce; a large wheat grower has a standing order for 2,000 gal.; and a group in Texas has offered to buy his entire production.

In addition, several large insectaries have now been established in Southern California for breeding ladybirds of the variety *Cryptolaemus montrouziei*, which was imported from Australia for the protection of the citrus crop. As it has to be bred, it is more costly than the indigenous variety, *Hippodamia convergens*, which is gathered under natural conditions, as previously described.

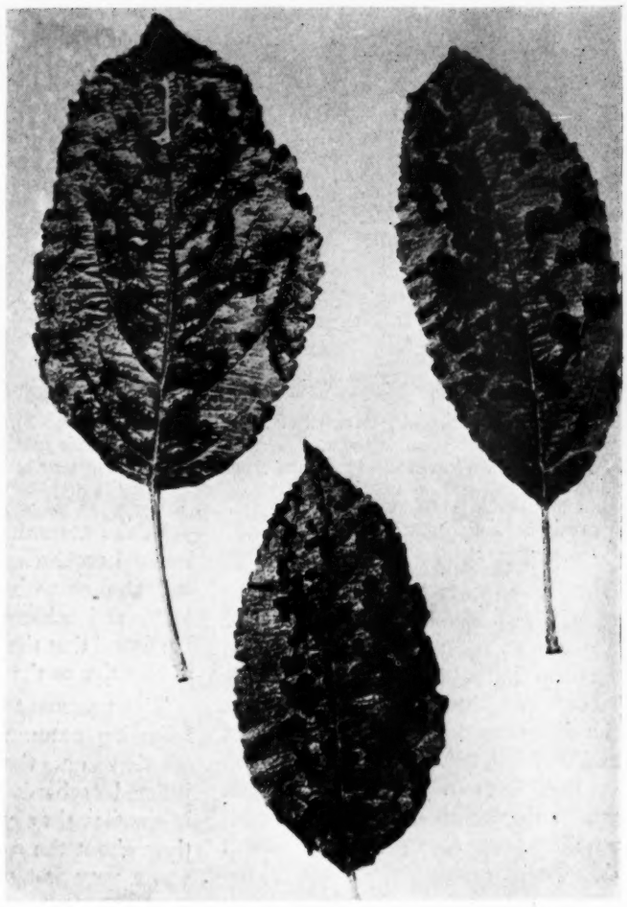
Above: *The ladybirds are scraped from their resting places into buckets and poured into boxes for cold storage*

Right: *The cardboard cartons are closed at each end with wire mesh and filled with corrugated cardboard*

Black Spot Disease of Apples

JOHN O'BRIEN

The scaly pestilence, black spot or scab, is one of the most costly of all apple diseases. The following is an account of recent work done by the New South Wales Department of Agriculture.



The effect of black spot, Venturia inaequalis, *on apple leaves. The primary spores of the fungus germinate on the leaves in the form of black spots, which are a mass of secondary spores.*

THE fungus *Venturia inaequalis*, which causes black spot, was first described and named in 1819. It is a primitive parasitic plant which lives on the tree during the growing season and produces many crops of spores. At the end of the growing season some of these spores have already lodged in the bud scales and twigs, where they may remain throughout the winter and germinate in the spring, infecting the young leaves and renewing the disease cycle.

The life history

Most of the infection, however, survives in the body of the fungus in the dead leaves which fall in the autumn, and during the winter months the fungus forms special structures, within which new primary spores are formed. These have tiny trigger mechanisms, which, when spring arrives, discharge vast quantities of primary spores into the air during rainy spells. The prolific activity of these mechanisms was measured by a Hirst spore trap, and a recent test in New South Wales showed that 2,000 primary spores could be collected in each cu. m. of air in an orchard.

The spores are spread by air currents throughout the orchard and whenever one lodges on a leaf or an apple and germinates a typical black spot appears. This really is a mass of secondary spores, each of which might cause further infection when carried by wind or rain to another part of the tree.

The scourge soon appears on blossoms, leaves and fruit. As an infected apple grows, the corky tissue of the diseased area remains static and the resulting stress causes cracks and serious distortion in the fruit.

Early treatment

For 66 years after the disease was first identified it could not be controlled satisfactorily, but about 1885 the discovery of Bordeaux mixture led to the use of spraying with a wide range of protective fungicides, which have been the standard method of control ever since.

Such treatment is expensive and during extreme infection periods is often unsatisfactory. The cost of spraying New South Wales orchards with the cheapest fungicides (Bordeaux mixture, followed by lime sulphur) is estimated at £A180,000 ($400,000) a year and when organic fungicides are used, this cost is doubled.

Since these represent only about a ninth of Australian apple and pear orchards, the total cost of spraying throughout the whole country may well be £A2 million ($4½ million).

Yet, although the trees in Australian orchards are not as susceptible to the disease as are those in wetter countries, and in spite of the huge expenditure involved, nowhere has the disease been fully controlled by protective spraying in bad seasons.

Since about 1935 two other methods have been tried. The first aims at killing the fungus during its dormant stage in the dead leaves on the ground by spraying with eradicant fungicides, but this has proved impracticable, because the dead leaves become lost in grass, blackberry bushes, weeds and loose soil, or blow in and out of neighbouring orchards, spreading the disease far and wide.

The second method aims at breaking the life cycle of the disease by applying an eradicant fungicide to the tree after the fruit is harvested, but before the leaves fall. Prof. G. W. Keitt, of Wisconsin University, tried this method, using sprays of copper-lime-arsenite mixtures, but in 1937 he reported that the sprays had damaged the trees without eradicating the fungus and so the experiment was abandoned.

The effect of black spot, Venturia inaequalis, *on the fruit. The lesions caused by the fungus grow into a corky substance, which remains static while the healthy portions of the fruit continue to grow. The resulting strain causes the cracks and distortions*

New methods

This was the position when K. Hutton, a plant pathologist of the New South Wales Department of Agriculture, commenced a study of the problem in 1952. He became convinced that the vulnerable period in the disease cycle was between harvest and leaf fall, when the infection was confined to the tree. The missing link was an eradicant fungicide which would be completely effective without damaging the tree.

A new group of organic mercury chemicals which had been demonstrated as extremely effective eradicants against other diseases was considered. One of these, phenyl mercuric chloride (PMC), had been successfully used against another disease of apples. It was not likely to injure the tree even when used at very high concentrations.

In late autumn (May) 1953, at Orange, N.S.W., 'Delicious' apple trees which were heavily infected with black spot were sprayed with PMC in 0.3% solution. Two weeks later, when the leaves began to shower down, he collected samples of sprayed and unsprayed leaves and let them winter under orchard conditions.

Results

During October, November and December, when the discharge of primary spores takes place, weekly samples of the leaves were examined. The result was consistent and dramatic. The unsprayed leaves poured out vast quantities of primary spores, but leaves, sprayed with PMC, developed none of the special trigger structures and discharged no primary spores whatever.

In the autumn of 1954 he sprayed isolated orchards at Yetholme, Batlow and Orange with PMC at 0.3% and 0.1% and achieved excellent control. He found that the weaker solution was as effective as the original 0.3%.

The treatment was repeated in the following autumn, using the weaker solution on three heavily-infected isolated orchards at Tumorrama and Maroota; they were left unsprayed throughout the ensuing season. This was a very wet summer, when black spot was rampant in other areas despite conventional protective spraying. The PMC-treated orchards showed only a trace of infection.

They were sprayed again in the autumn of 1956 and again were left unsprayed throughout the subsequent season. In two there was not a single infected apple; in the third there were a few very lightly infected. Leaf infection was practically absent in all three. In one orchard of 220 trees, where the disease had previously been rife, there were only four lightly infected leaves.

There still remained the adjacent uncontrolled orchards, which seemed to be preventing total eradication. It was therefore decided to treat every apple tree in the Yetholme district—an isolated area of over 40 farms, covering a total of 170 acres. These were sprayed with PMC in the autumn and conventional spraying was reduced to a minimum during the ensuing season. The growers subsequently had the satisfaction of harvesting the best quality fruit in memory. One orchardist, who packed 1,100 cases of apples, found only six lightly infected fruit.

This experiment is continuing and, though the results so far achieved seem conclusive, the Department of Agriculture is not yet prepared to recommend the use of PMC autumn spraying without further trials.

Recommendations

Three applications of this new method are, however, being recommended:

1. For isolated orchards, the single annual spray of PMC at 0.1% at a cost of £A6 15*s.* ($15) per 100 gal. This is about the same cost per acre as one season's application of protective fungicides and it may result in complete eradication after two or three years of treatment.

2. For certain whole districts, with the complete co-operation of all the growers, the same results could be obtained with the same treatment.

3. The use of PMC at 0.01%, which costs about A13*s.* 6*d.* ($1.50) per 100 gal., will give a 95% reduction or partial control in the carry-over of spores from one season to the next.

Technical News

Articles in the November issue of some of the other journals of the Leonard Hill Technical Group include the following:

Paint Manufacture. – 'Guide to New Pigments'; 'Aluminium: Versatile Pigment – 2'; 'Importance of Particle Size'.

Building Materials Export. – 'The Behaviour of Paints in Tropical Climates' by P. Whiteley, B.SC., A.R.I.C.

Dairy Engineering. – 'Production and Utilisation of Power and Heat in German Dairies' by Prof. Dr. Ing. Wälzholz; 'Transport of Milk by Road' by E. H. B. Palmer; 'Italy's Most Modern Dairy'.

Automation Progress. – 'Computers for the Businessman' by Dr. A. D. Booth.

Food Manufacture. – 'The Swedish Sugar Industry' by John Grindrod; 'Fruit Freezing in the United States' by Prof. George Borgstrom; 'The Problem of Improving Nutritive Value with Special Reference to the Enrichment of Foods – 5' by E. Menden and B. D. Cremer.

Specimen copies of the above journals are available on application to Leonard Hill House.

Insecticides and the Balance of Nature

SPECIALLY CONTRIBUTED

The extensive use of chemical insecticides in agriculture and horticulture is frequently subjected to severe criticisms on the grounds that this practice is upsetting the balance of nature.

IT is necessary to dispel any illusion which may exist that civilised man lives in a state of nature. This is very far from being the case. Throughout the centuries, man has lived and developed in an unnatural environment which he has created for himself to suit his way of life, and which has become progressively further removed from the naturally balanced state which existed in primitive times. The environment of man is balanced, albeit artificially and precariously, and a reversion to a state of nature would inevitably result in universal starvation and the collapse of our civilisation.

Powerful new weapon

The introduction of chemicals for use in agriculture has placed a new weapon in the hands of man to protect his crops and livestock against the ravages of pests and diseases and assist him to compete successfully in the struggle for existence. The use of this very potent weapon has developed so rapidly that there is every justification for public concern that agricultural chemicals should be employed with discretion.

Destruction of friend and foe

There are several possible undesirable effects of using agricultural chemicals upon which reassurances are sought. One of these concerns the destruction of beneficial predatory insects by the insecticides which are applied to control crop pests. When it is claimed that beneficial insects are also destroyed after many chemical applications (in the absence of an insecticide which is completely selective between friend and foe) it must be admitted that this statement is not entirely wrong. The extent of this destruction will vary considerably, according to the insecticide, which is used, and the way in which it is applied.

Cabbage stem weevil maggots in the stem of an old leaf

Insecticides with strong contact action and long persistence are the most destructive to predators, but this does not mean that their use should be condemned, because they may provide such a complete control of certain pests that assistance from predators is not required. Stomach poisons, such as lead arsenate, are relatively innocuous to predators, and the same applies to systemic compounds which have little or no contact or fumigant action, such as schradan, and acaricides, such as chlorbenside. Generally speaking, such chemicals, which are comparatively harmless to predators, are fairly specific in their uses and will only control a limited range of pests – lead arsenate will only control chewing insects, such as caterpillars; schradan is used almost exclusively against aphids; and chlorbenside is specific to certain mites, such as fruit tree red spider.

Protection of friends

The destruction of predators can be reduced by adopting certain methods of application in preference to others. Thus, for instance, the use of insecticidal seed dressings or root dips, or the

Photos: Plant Protection Ltd.

A colony of mealy aphis on cabbage

placement of insecticide close to the seed by combine drilling, will control soil pests, such as wheat bulb fly and cabbage root maggot, quite as effectively as broadcasting. With these methods, too, a smaller amount of insecticide is used and it is placed where it is most needed to control the pest, so that soil predators are less likely to be harmed.

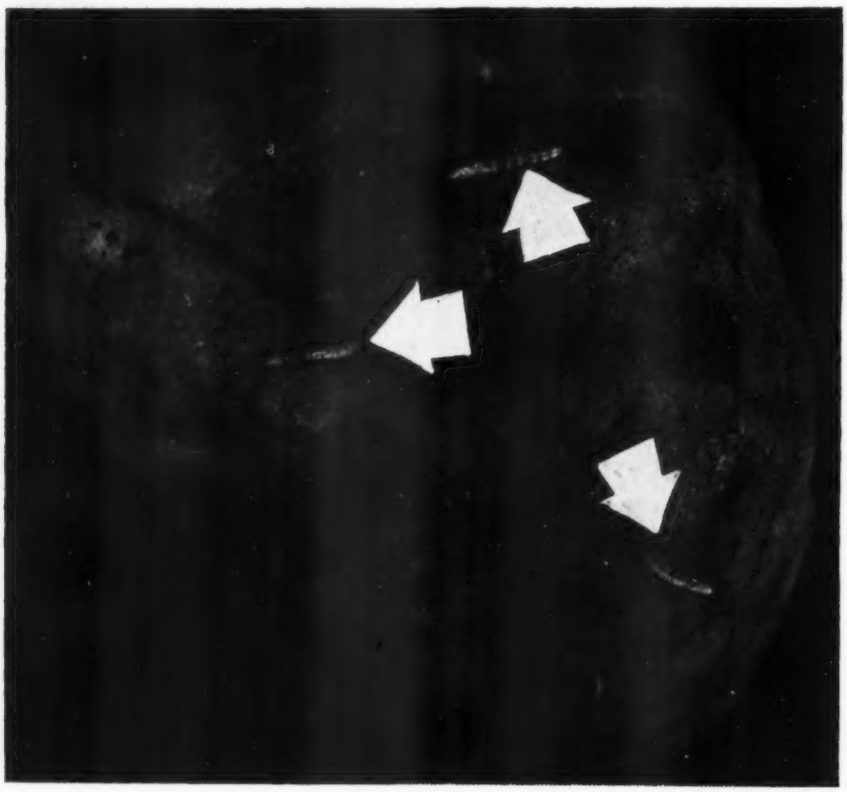
As another example, some pests, such as mangold fly, may be controlled quite adequately by low-volume spraying to cover only the top surface of the foliage. Predators which spend much of their time under the leaves thus have some degree of protection against the spray.

Selective action

It is sometimes suggested that insecticides of moderate potency, preferably with some selective action, should be used in preference to those which have high activity against a wide range of pests. It is argued that this would result in the pests being kept down to a level at which they would not cause serious crop damage, but would leave sufficient of them to support their predators. This would overcome the possibility of predator populations being reduced to a very low level by extensive destruction of their food – the pest.

It is doubtful whether many growers and farmers whose main concern is to remove pest infestation from their crops would support the practical adoption of this theory, and it is also questionable whether it could be put into practice successfully. The behaviour of pests and predators is largely unpredictable with our present knowledge of their habits and of the many seasonal factors which influence their appearance and the density of their populations. Predators can control quite heavy pest infestations successfully, but often they will fail to put in an appearance when required and, in any case, there is a time lag before they can exercise control, during which appreciable damage and loss of crop may be sustained.

The apple blossom weevil, Anthomus pomorum – *an adult enlarged eight times*



Photos: Shell

Larvae of wireworms, Agriotes spp., *emerging from a potato*

Restricted operations

The argument against pest extermination by very active insecticides can only be valid when extensive chemical treatment is given over a very large area. Chemical applications of sufficient concentration to have this effect are unlikely to be practised in this country so far as annual crops are concerned, bearing in mind that most insect pests have alternative hosts and that predators will feed on several different species of insect, some of which will not be found on sprayed crops.

In attempting to assess the case for and against the use of chemical pesticides it should first of all be recognised that predators can perform a useful function. Therefore, all reasonable steps should be taken to minimise their destruction by the use of selective insecticides, where appropriate on the score of efficiency, safety and cost. When highly active contact chemicals are used, they should be applied in such a way that they will control the pest satisfactorily with minimum predator destruction.

Agricultural production has increased very considerably since chemical pesticides have been widely used by British farmers, and this higher production would not have been possible without them. To cite examples; serious pests which were often the despair of farmers before chemical warfare started include apple sucker, capsid bug, apple blossom weevil, wireworm, mangold fly, flea beetle, pea weevil and aphids of all kinds. Some of these pests are no longer serious and others can easily be kept under control today.

A.B.M.A.C.

Our readers will be interested to learn that the 'Association of British Insecticide Manufacturers' has changed its name to the 'Association of British Manufacturers of Agricultural Chemicals' in order to cover the production of all crop protection and pest controlling chemicals. The newly-elected President for 1958-59 is Mr. H. G. Huckle, Agricultural Marketing Manager, Shell Chemical Co. Ltd.

The delegates at the Second African Weed Control Conference photographed at the Victoria Falls

Weed Control in the Tropics

THE Second African Weed Control Conference was held in the delightful surroundings of the Victoria Falls in Southern Rhodesia. It represented a further, significant step in the development of tropical agriculture and is yet another landmark in the new science of weed control by chemicals.

The Conference brought together a large and distinguished gathering of agricultural scientists and research workers from Angola (W. Africa), Belgian Congo, Mauritius, Kenya, Tanganyika, Southern Rhodesia, South Africa, U.K. and the U.S.A.

The papers that were presented to the Conference dealt with the eternal problem of the rapid growth of destructive weeds and of shrubby growths in the forests and pastures and among the plantation crops of equatorial Africa. The following is a short summary of some of them:

Conference on bush and scrub control, and on the control of weeds in arable and plantation crops.

Tree and Scrub Control Problems in East Africa *by G. W. Ivens* (*Colonial Pesticides Research Unit, Tanganyika*)

Problems of controlling woody plants in East Africa are mostly concerned with grassland improvement, the throwing-out of shade trees in plantation crops, bush-clearing for tsetse control, or forest improvement The work of the Uganda Forest Department has shown that arboricides can be used successfully to kill unwanted tree species in indigenous forest and a mixture of 2,4–D and 2,4,5–T is now being used on a large scale for this purpose.

In general it appears that the aerial parts of most species can be killed with oil solutions of these chemicals at concentrations between 0.5 and 2.0%, a.e. Many species appear to be equally affected by both chemicals, but some, in particular the *Acacias*, are more susceptible to 2,4,5–T than 2,4–D. The success of treatment depends on the powers of regeneration of the trees from below ground. With species which only produce regrowth from the above-ground parts of stumps, arboricides usually give good results. With some of those capable of regenerating from below ground, however, results have been unsatisfactory and it is evident that the chemicals are not translocated very far in a downward direction from the point of application. These species are also those which are least susceptible to ringbarking, burning and other methods of clearing.

Arboricide and Herbicide Trials on Natural Pastures in Southern Rhodesia *by W. B. Cleghorn* (*Grassland Agricultural Station, S. Rhodesia*), *A. D. McKay* (*Matopos Agricultural Research Station*) *and C. H. Cronin* (*Fisons Pest Control* (*Central Africa*) *Ltd.*)

This informative paper gives a broad outline of the vegetation climax in Southern Rhodesia and the desirability of reducing the density of certain woody species in order to improve natural pasture by increasing grass cover.

The trials described are in the nature of a preliminary exploration into the possibilities of woody regrowth control by chemical means and were not integrated with follow-up management practices. The data obtained indicate that regrowth from apparently dead trees outweighs the number of kills taking place following applications of the arboricides used.

The method of applying the arboricide under the conditions of the trials was found to be a major factor governing its effectiveness. With non-foliar treatments, the effectiveness was closely related to the amount of mechanical damage applied immediately prior to chemical treatment. Unfortunately, the treatment of freshly-cut stumps, the most effective method, is also the most laborious, not only on account of the cost of labour and machinery but particularly because of the length of time needed to carry out treatment. Where thick coppice is met with, such treatment would be almost impossible.

The uniform application of a sufficiently high rate of arboricide to kill all species likely to be encountered might be liable to render the treatment

uneconomic, especially where bush density is high and the land is therefore of very little immediate grazing value. However, it is not always necessary or even desirable to remove all woody growth from pasture, as some species have a browse value, while others provide shade.

If arboricides are used, they and their diluents should not constitute a toxic hazard to stock. The most effective arboricide used was arsenic but, as it is toxic to all stock, its use would probably be precluded from such areas. In addition to their toxicity some, at least, of the soluble arsenic compounds render treated material palatable to stock. This, in conjunction with the facility with which arsenical compounds can remain in or on wood in a toxic form for a considerable period, makes their use in any situation where stock or even game could have access to them inadvisable.

The future objective in large-scale pasture improvement should be to find an effective chemical that can be applied cheaply from aircraft, since ground applications are laborious, time consuming and expensive.

La Destruction Chimique de Bananiers *by R. N. Tas (INEAC, Yangambi)*

Experiments carried out at Yangambi have shown that it is possible to kill old, unproductive bananas by injecting an aqueous emulsion containing 0.5% 2,4–D a.e. at the dose of 15 c.c: per stem, or by spraying an aqueous emulsion containing 0.2% 2,4–D a.e. at the dose of 200–300 c.c. per stool on the young leaves.

Chemical killing of bananas is cheaper than manual destruction, and foliage spraying cheaper than injection, as it takes less time.

Weed Control in Maize in Southern Rhodesia *by J. R. Tatterfield (Gwebi Agricultural College) and C. H. Cronin (Fisons Pest Control (Central Africa) Ltd.)*

Graminaceous weeds can be a very serious problem and none of the herbicides at present available regularly gives adequate control. Certain machinery, such as rotary hoes, will control them under favourable conditions, but they can only be used during early crop growth. There is, then, a definite place where graminaceous weeds are a problem for either a new herbicide or for the extended use of MCPA or, preferably, 2,4–D for controlling at least dicotyledonous weeds when the crop is too high for tractor cultivation. To be effective, directional application at the 8–12 leaf stage must prevent dicotyledonous weed reinfestation until the maize has shown sufficiently for it to exert a shade effect. This paper presents promising results achieved with 2,4–D amine at 0.5 lb. a.e. per acre, a sufficiently cheap treatment to make it an economic proposition.

Where monocotyledonous weeds are not a problem, the cost of the pre-emergence herbicide application could be reduced by directional spraying along the rows, if between-the-row tractor cultivation is to be carried out for purposes other than for weed control. The only feasible time at which to carry this out is at planting, which appears to entail a certain risk of crop damage unless the seed is planted deep and is consolidated before spraying.

The residual herbicides at present available, such as Diuron, do not appear to be attractive for use under Southern Rhodesian conditions due, at least in part, to their high cost.

Pentachlorophenol for Grass Control in Rice *by C. Parker and D. S. Byers (Fisons Pest Control (S. Africa) Ltd.)*

Grasses, and especially the genera *Echinochloa* and *Panicum*, are among the most serious weed problems in rice in many parts of the world. *Echinochloa* spp. in particular are recorded as important weeds in the U.S.A., Brazil, France, Russia, Surinam and the Philippines. The work reported in this paper was on the serious problem of *Echinochloa* in rice on the Colonial Development Corporation's Swaziland Irrigation Scheme.

To control a proportion of the infestation of weed grasses in rice fields, the land may be flooded to encourage germination, and then the weeds killed either by pre-drilling cultivations or by various pre-drilling chemical treatments. In particular, pre- or early post-weed emergence sprays with 2,4–D, or early post-weed emergence sprays of TCA, dalapon, PCP, dinoseb or amino triazole may be used. These can be extremely effective in destroying the weeds that have germinated, but there must be either an interval for microbiological breakdown, or extra flooding to leach out the herbicide (or both), before the crop can be safely sown. Furthermore, under the conditions prevailing, it was not possible to drill the rice into such a flooded seedbed, without further cultivation, and this is always liable to disturb fresh weed seeds and partly negate the results of treatment.

PCP was considered to have the advantages of greater selectivity, lower cost, and lower mammalian toxicity, and is now in regular use on the scheme.

Trials with Simazin as a Pre-emergence Herbicide in Maize *by G. W. Ivens (Colonial Pesticides Research Unit, Arusha, Tanganyika)*

The new herbicide developed under the name of Simazin (2-chloro-4, 6-bis-ethylamino-S-triazine) has been shown in Europe to be non-toxic to maize at rates giving a high percentage kill of many weeds. Its effects were compared with those of 2,4–D, the chemical most frequently used in East Africa for weed control in maize.

The results of the trials suggest that Simazin is also a very promising herbicide for use against East African weeds in maize. At rates of the order of 1 lb./acre, or less under specially favourable conditions, it kills a wide range of weed species at stages from germination to a height of 1–2 in. and maintains the control for a prolonged period without causing damage to the crop. It appears that to be effective the chemical must be used on plants growing under moist conditions. On emerged weeds it is probably even more important than on germinating seeds, for there to be sufficient rain to carry it into the root zone.

2,4–D gave good results at a rate of 1 lb./acre. It was more effective than Simazin when applied in dry weather from 1 to 3 weeks before weed emergence, but somewhat less effective on germinating and very young weeds. Its effects are less persistent than those of Simazin.

Although 2,4–D at 1 lb./acre is safe in maize as a pre-emergence spray or on plants less than 6 in. high, it may cause injury to older plants. Simazin has the advantage of a greater degree of selectivity and might be used in some situations where 2,4–D would not be safe.

(To be continued)

Soil Inspection Pits

When inspecting an area of virgin jungle or bush to determine its suitability for alienation as agricultural land, it is always sound practice to open up inspection pits, say one every acre, or one in every five acres, depending on the extent of the area

An infertile eroded laterite soil with ironstone boulders

SOIL analysis is only useful in certain circumstances. Visual examination of soil samples can be useful, but more satisfactory information can be obtained from an examination of the soil *in situ* and particularly of its profile as exposed in an inspection pit. Soil inspection pits allow easy observation of such important factors as impeded or excessive drainage, the presence of concretionary layers of rottenstone or ironstone or of discrete layers of peat, sand or clay. The reason for patchily poor growth is often revealed when inspection pits are dug and even where specific problems do not exist the comparative fertilities of the different soils on an estate can be assessed by examining their profiles, and rational fertiliser programmes are then easier to prepare.

Method

The pits should be some five feet deep, about three feet square and have vertical sides. When examining the soil there are several main points to look for. The first is the texture of the soil; by this is meant the proportions of sand, silt and clay in the soil, these proportions determining whether the soil should be classed as a sand, loam or clay or some intermediate type such as a sandy loam or loamy clay. Take a small amount of soil and rub it between the fingers; a sandy soil will feel rough and gritty to the touch whilst a clay soil, which is composed of the finest of soil particles, will feel smooth and when moist can be readily moulded in the hand.

Soil texture will often vary down the profile but experience will enable the observer to attain some discrimination in identifying the many gradations possible between coarse sand on the one hand and heavy clay on the other. In general, the greater the proportion of sand in a soil the lower will its nutrients content be and the more necessary will it be to use liberal dressings of fertilisers.

Another important point is the colour of the soil. Brown, reddish brown and reddish yellow loams and sandy loams are usually more fertile than those that are light yellow or grey in colour. Limestone and volcanic soils are rich brown in colour and not to be confused with some of the reddish brown laterite soils.

Soil colour is also linked with the drainage status of the soil. Examination of the soil topography will have indicated whether drainage is likely to be abnormal or not, but sometimes the presence of impermeable layers of heavy clay or of ironstone can limit drainage, even on sloping areas where

Black peat over white sandy clay in a recently cleared swamp area

drainage might be expected to be good. When the inspection pit cuts through the normal water table the latter will be indicated by a diffuse band of yellow or orange mottling. This colour is due to localised deposits of iron hydroxides formed in the soil during alternating wet and dry conditions. If the mottling exists within two feet of the surface, the drainage needs improving, but if no such mottling occurs or does so only diffusely in the lower soil layers then the drainage can be considered satisfactory.

A depression of vigour in rubber trees caused by an abrupt change in soil type. Posts mark the points where two inspection pits were dug; one revealed a fine sandy loam, the other a thin infertile sand

The presence, near the surface, of parent rock or of concretionary layers of ironstone or laterite, will also be revealed by the inspection pit. If sufficiently impenetrable, these layers limit root development to the upper soil layers and the trees will suffer from nutrient and water shortage and may also be liable to wind damage.

There are, of course, many other factors which may not be of general occurrence but which can severely affect tree growth under local conditions.

Abstracted from the *Planters' Bulletin*, January, 1958, published by the Rubber Research Institute of Malaya.

Commercial Vehicles

The 1958 Commercial Motor Show, held in London, was the largest exhibition of its kind ever held anywhere in the world, with 435 stands showing light cross-country vehicles, which will have to fight their way through jungle, mud and sand, to mammoth tractors for hauling pay loads of 80 tons. There were also vehicles of exceptional power for travelling over rough unmade roads with speed and safety.

This year the most outstanding development was the improved suspension and comfort obtained by incorporating air and foam rubber units. The diesel engine now dominates in the medium and heavy classes of commercial vehicle, and this will be the biggest factor in the reduction of operating cost per ton-mile. Driver amenities have been improved in respect of the seat, visibility, the position of controls and in the provision of facilities for heating or cooling the cabin.

Of particular interest to plantation managers, farmers, forest officers and field personnel was the ' Land Rover ' exhibited by the *Rover Co. Ltd.*, the ' Jeep ' shown by *Willys Overland Export Corporation of U.S.A.* and the new *Austin* ' Gipsy ', all of which are designed for work under the most arduous conditions. The first two vehicles were described in our August and September issues and the last will be reviewed in a forthcoming number.

British Territories Overseas

A Conference of Directors of Agriculture and Senior Members of Overseas Departments of Agriculture and Agricultural Institutions was held last month at Wye Agricultural College to discuss the questions of land use and farm planning, soil fertility, mechanisation of agriculture, the training of the professional agriculturist and the functions of advisory services. An address on recent developments in the use of isotopes in agriculture was given by a representative of the Atomic Energy Authority.

The Conference was attended by officials from 28 colonies, representatives from the Empire Cotton Growing Corporation, the Colonial Development Corporation, the Ministry of Agriculture, Fisheries and Food and the School of Agriculture, Cambridge.

Mechanisation in the Belgian Congo

The Belgian Congo is a comparatively small but potentially important market. Under the second Ten-Year Plan, which begins in 1960, certain areas plan to spend up to £10 million on agricultural development. A considerable proportion of this sum will be spent on agricultural machinery, which will be used to step up the production of principal crops, such as coffee, cotton, maize, beans, groundnuts and tobacco.

Tropical vegetation dwarfs this David Brown 25D tractor, which is being driven by a coffee grower in the Belgian Congo

New Publications

Lesnaya Promyshlennost SSSR Statisticheskii Sbornik

Compiled by B. I. Shteinbok. First edition. In Russian. pp. 295. Goslesbumizdat, Moscow-Leningrad, 1957. 13 roubles 50 kopeks, approx. 25s.

Statistics is often a slippery subject, and particularly is this so in the case of Soviet statistics, where all too often production figures are given in terms of fairly meaningless percentages of pre-revolutionary output, and not in hard and fast actual volumes or numbers.

Therefore this Statistical Compendium of Forestry and Woodworking Industries of the U.S.S.R. is to be welcomed, for it contains full data of Soviet timber production for the 40-year period from the Revolution in 1917 to October, 1957. The book is composed of 115 tables and 20 graphs, plain text being limited to a two-page introduction.

Details are given of the total area of forest and of the annual cut, by age classes, softwoods and hardwoods, and administrative regions, and of methods of felling and extraction. The labour force available, men, horses, powered vehicles and machinery, is analysed, and wages and productivity figures listed for various types of work and end-products. Data on sawtimber, plywood, furniture production etc., as well as capital expenditure on roads, bridges etc., in forestry is also included.

Of considerable interest is the final tabular country-by-country review of world forest resources and timber yields, from which can be seen the leading place which the Soviet Union occupies in forestry and forest products, particularly of coniferous species.

The book, which is clearly printed and well produced, forms an indispensable work for the forest economist.

W. LINNARD

Grassland Investigation

Grassland in England and Wales, by V. H. Beynon. Pp. 59, diagrams. University of Bristol, 1958. 5s.

A five-year investigation into the intensive use of grassland is being carried out by the Agricultural Economics Branch of Bristol University, with the aid of a substantial grant from Fisons Ltd. The above is a preliminary report on the problems of grassland utilisation. It is divided into four main sections: the first deals with the importance of grass in England and Wales; the second deals with methods of measuring outputs from grass, with a critical discussion of each; the third compares existing levels of performance; and the fourth discusses the factors which influence output and analyses the output and profit margin per acre on farms applying various rates of nitrogen.

Farm Prices—Myth and Reality

By Willard W. Cochrane. Pp. 189. Minnesota University Press. London: Oxford University Press, 1958. Price 32s.

Farm prices constantly fluctuate, leading to variable incomes, low incomes over extended periods and uncertainty in production planning. In this study Professor Cochrane seeks to get at the root of the trouble.

Concentrate Spraying

Concentrate Spraying in Deciduous Orchards, by J. Marshall. Pp. 47, illustrated. Ottawa, Department of Agriculture of Ontario. 1958. $1.00.

This bulletin is written for fruit growers as well as technical workers. The literature on concentrate spraying is reviewed and pertinent information is added from experiments and from experience in British Columbia.

O Sisal

By J. C. Medina. Pp. 286, illustrated. Sao Paulo, Brazil, Director of Agricultural Publicity. In Spanish. 1954. For limited distribution.

This book gives a complete account of the sisal industry in Brazil, covering selection, breeding and nursery practice; land preparation and planting practices; the collection and carriage of the leaves; the extraction, cleaning and grading of the fibre; and the preparation and baling of the product for export.

Controlling Aquatic Weeds

Progress Report No. 69, published by the Agricultural Experiment Station of the Alabama Polytechnic Institute of U.S.A. This report summarises in tabular form by plant groups all pertinent information concerning control methods used for the more objectionable weeds, with major emphasis on their application to fish ponds; also included are summaries of toxic effects of chemicals on fish, as well as on higher animal forms.

Sugar Year Book for 1957

This is the eleventh issue of the Year Book, published by the International Sugar Council. The latest issue – still of pocket size – has been enlarged to include statistics on sugar which has been provided by governments who are not parties to the International Sugar Agreement. Price 10s., post free.

FAO Publications

Report of the Council of FAO – 27th and 28th Sessions, 1957, in English, French and Spanish deals mainly with administrative matters, such as policy with regard to assistance in establishing regional research and training institutes, the establishment of a C.C.P. Study Group for dates, and the appointment of chairmen and members of various committees.

Poplars in Forestry and Land Use, Forestry and Forest Products Studies, No. 12, 1958. Pp. 511, illustrated. The paper used for this publication contains 20% poplar pulp.

To grow as much timber as possible, and grow it quickly, is an urgent necessity. Poplars can make an important contribution to world supplies, as they have a rapid growth rate; their wood is well suited to the production of veneers, light box-making materials, fibreboards and paper pulp. Poplars provide the answer to countries lacking forests and interspersed on cultivated land they provide the people with firewood and timber. Today the cultivation of all plants which man needs depends for increased productivity on scientific research and on the planting of tested and proved lines. Precise knowledge of both the biology and the

correct environmental requirements of any plant is necessary for it to be grown profitably and that is the purpose of this most useful book.

Report of the Third Session of the FAO Group on Grains. C.C.P. 58/16, Rome, 1958. Pp. 24.

The Group has reviewed recent developments in the grain situation with respect to production, trade and prices, and the outlook for the year 1958–59.

Pea Growing Handbook

The 1958 edition of this handbook has been completely rewritten and greatly expanded and now gives comprehensive coverage of vining as well as threshed peas. The contents are divided into three main sections, *viz.* 'General Husbandry', 'Pests and Diseases' and 'Harvesting'. A pocket in the back cover is designed to hold supplementary leaflets which it is intended to issue as and when new information becomes available.

Obtainable from the Pea Research Station, Yaxley, Peterborough, Northamptonshire, price 2*s.* 6*d.*

Commonwealth Economic Committee

Vegetable Oils and Oilseeds, 1958. This is a review of production, trade, utilisation and prices relating to groundnuts, cottonseed, linseed, soya beans, coconut and oil palm products, olive oil etc. World production of vegetable oils in 1956–57 was approximately 6% greater than in the preceding year and the heaviest yet recorded. Preliminary figures for 1957 indicate a small decline in world trade, due no doubt to increasing consumption in countries of production. Obtainable from H.M.S.O., price 5*s.*

Manuring of Coconuts

Coconut Bulletin No. 4 of 1958, issued by the Indian Central Committee, Ernakulam, S. India. Rs. 2, or 4*s.*, post free.

This is a special fertiliser number to synchronise with the coconut-manuring season, which is August–September for the major coconut-growing areas. Coconut palms do respond to manuring and this bulletin is a review of various problems which face growers and active propaganda to make manuring a regular practice in India.

Empire Cotton Growing Corporation

Annual Report 1958 *with Progress Reports from three Experiment Stations for the Season* 1956–57. Cotton production in the territories supervised by the Corporation in the season 1956–57 totalled well over 1,400,000 bales, some 200,000 bales more than the previous season, and a new record; the main increase came from the Sudan, where a crop of 700,000 bales was produced, which is 33⅓% greater than that of the previous year; another record crop was harvested in Tanganyika for the fourth successive year.

Obviously the effects of the new strains selected or developed by the Cotton Research Institute are making themselves felt, but, unfortunately, there have been more diseases than usual during the past year. *Fusarium* wilt disease was found on an increasing scale and bacterial blight disease continued to take its toll, in spite of the increased use of resistant varieties and treatment of the seed before planting. Investigations into the relationship between soil moisture and yields of cotton are being undertaken.

The Progress Reports from Experiment Stations, Season 1956–57, for Kenya and the West Indies, and a Survey of Reports are also available from the Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1, price 1*s.*, post free.

Annual Reports

The Annual Report for 1957-58 *of the European and Mediterranean Plant Protection Organisation.* Printed in French and English. Pp. 32.

The Report for 1957 *of the Rothamsted Experimental Station* (with a 50-year index: 1908–57). Pp. 316. Copies obtainable from the Librarian, Rothamsted Experimental Station, Harpenden, Herts, price 10*s.* post free.

Report of the Government Chemist, Tanganyika, 1957.

Annual Report of the Grassland Research Institute contains original articles and an account of experiments in progress. Price 7*s.* 6*d.* from the Librarian, Grassland Research Institute, Hurley, near Maidenhead, Berkshire.

Eighth Annual Report, 1957, *of the National Vegetable Research Station.* Pp. 67. Enquiries to the National Vegetable Research Station, Wellesbourne, Warwick. Price not stated.

1957 *Report of the School of Agriculture, University of Nottingham.* Pp. 80, illustrated. Obtainable from the Secretary, University of Nottingham School of Agriculture, Sutton Bonnington, Loughborough.

West African Cocoa Research Institute, Annual Report, 1956–57. Pp. 90. Price 5*s.* from Crown Agents for Overseas Governments and Administrations, 4 Millbank, London, S.W.1.

N.I.A.B.

Thirty-eighth Annual Report and Accounts of the National Institute of Agricultural Botany, 1957. This gives an account of the breeding work done on cereals, legumes, root, fodder and vegetable crops during the past year and of the work done in seed testing and certification. In this report it is stated that the draft rules for the varietal certification of herbage seed moving in international trade was finally considered at OEEC and that it is hoped that the rules will be in operation for the 1959 harvest.

Other Publications

Forestry Commission Bulletin No. 14, '*Forestry Practice*'. Summary of methods of establishing forest nurseries and plantations, with advice on other forestry questions for owners, agents and foresters. 7th edition. 1958. Price 6*s.*

Field Beans, by M. H. R. Soper, M.A. Price 1*s.* 9*d.* H.M.S.O.

Bulletin No. 138 on irrigation, with notes on crops to which it is applicable. 2nd edition of February 1954, reprinted with amendments, May 1958. H.M.S.O. Price 4*s.* 6*d.*

Disease and Pests on Horticultural Planting Material. A guide to their recognition. 2nd edition. April 1958. H.M.S.O. Price 7*s.* 6*d.*

Bookshop Service

Books reviewed in WORLD CROPS and all other scientific or technical **books** may be obtained from:

Technical Books,
308 Euston Road,
London, N.W.1.
Telephone: Euston 5911.

Other miscellaneous publications reviewed should be obtained direct from the addresses given.

Machinery and Equipment

Scrub Clearance

The ' Swipe M 11 ' was designed for lighter work, such as clearing potato haulm and kale. Now *Wolseley Engineering Ltd.* have introduced the ' Super Swipe ', also for attachment to the 3-point linkage of tractors, which will use the full power of the tractor. It will cut down gorse and tangled growths up to 12 ft. in height, leaving a carpet of clipped vegetation 4 in. deep; it will tackle rushes and scrub and cut them down to within 1½ in. of the ground if required, or it will deal with the toughest and coarsest grass equally effectively and quickly.

Powerful Concentrate Sprayer

The ' Micron Twin ', a product of *Micron Sprayers Ltd.*, is a concentrate sprayer which has been designed at the request of hop, top fruit, soft fruit, vine and coffee growers, who require a very powerful sprayer for automatic spraying. It can be attached to the hydraulic lift of a tractor and driven by the p.t.-o. The machine develops such momentum that the turbine-driven atomisers are not likely to be reduced in efficiency when the tractor is slowing down for the end of rows, nor when its wheels are skidding on wet land. Its two 18-in. dia. cast-aluminium paddle-type fans each deliver 2,000 cu. ft. of air per minute and provide sufficient air for spraying even tall tree crops. The fan case can easily be removed to allow the fan unit to be taken down for inspection and cleaning.

Its centrifugal pump is fitted with 'Tufnol' glands to withstand the abrasive action of all spray chemicals and a large proportion of its output is returned to the spray tank to provide most vigorous agitation.

The tank is constructed of heavy gauge steel and forms the chassis of the unit and is galvanised to protect it from corrosive action of spray chemicals. The filler hole is extremely large and this not only allows easy and rapid filling, but also gives access to the interior of the tank for cleaning. The tank is designed so that, in combination with the return flow from the pump, the spray liquid will be continuously agitated during spraying operations. A large drain plug is situated at the base of the tank for swilling out residues. It has a capacity of 30 gal., which is sufficient to cover between four and 10 acres of crop per filling.

The Wolseley ' Swipe ' tackling dense undergrowth. The vegetation consisted mainly of brambles and was in places 8 ft. tall

The Eversman hydraulic scraper engaged in dam construction

The ' Micron Twin ' concentrate sprayer has two turbine-driven atomisers

As its name suggests, the machine has two outlets connected to the fan cases by a short length of flexible hose and bolted on an infinitely variable quadrant which allows the beam of air and spray to be directed in any desired direction. Both outlets contain rotary atomisers and the droplet size varies with the speed of rotation. The atomiser bearings are completely sealed against spray liquid and dust.

The ' Micron Twin ' weighs only 6 cwt. when fully charged with spray liquid; this means that it can easily be used as a tractor-mounted unit on wet land without doing damage to soil structure and plant roots.

Earth Moving and Levelling

A new hydraulic scraper has been added to the *Eversman* line of agricultural earth - moving equipment, which can be used by the farmer for a great many earth-moving jobs – fast and at low cost with his own tractor.

The new scraper has proved to be an ideal implement for contour correction, grading fields, making surface ditches or waterways, filling gullies and low spots and building terraces, reservoirs, ponds, dams, levees and pit silos. Its most important feature is the front dump operation, which permits the operator to control the fill and to spread the dirt in an even, constant flow. The cutting bit also smooths out previous fills and eliminates the undesirable feature of rough, heaped, uncontrolled dirt piles.

The tractor used must be equipped with a two-way hydraulic pump, since control of scraping, hauling and dumping is by means of a single hydraulic

control valve. The smallest movement of this valve produces an immediate response in lowering or lifting the bucket. An inexperienced operator can learn to handle the machine in a matter of minutes.

A Washing Unit

A useful unit for washing vehicles and implements is offered by *E. Allman & Co. Ltd.* It will fit on to the p.t.-o. shaft of any tractor and is held in position by a simple check chain. The pump develops pressures up to 200 lb./sq. in. and the flow of water can be varied from a pencil jet to a fine mist, according to requirements. Any overload is automatically adjusted by the relief valve and the surplus water returned to source through a return hose.

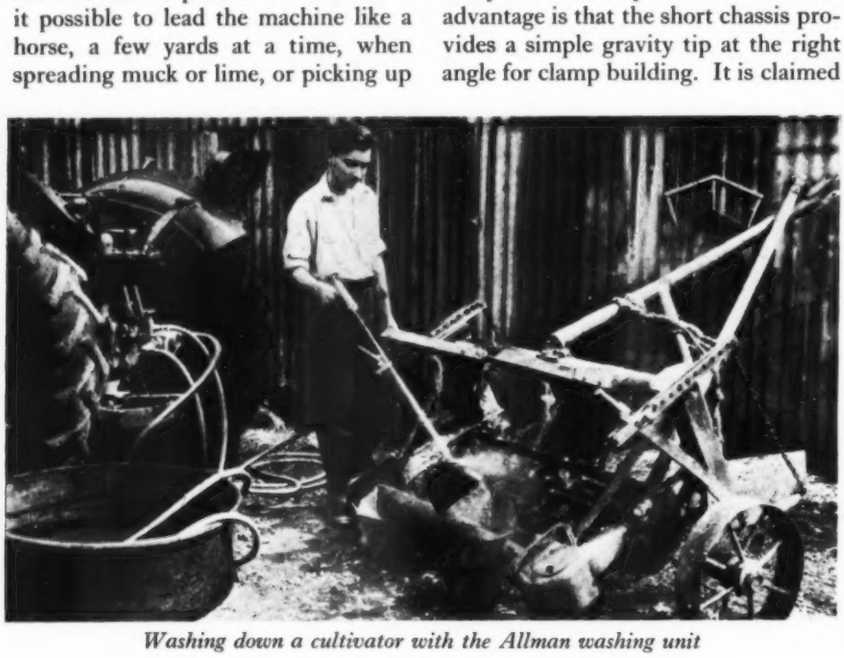
The unit is supplied complete with all hoses, relief valve and storing cradle.

The driver can walk beside the ' Motocart ' and do ' stop-start ' jobs as easily as with a horse and cart

A Mechanical Horse and Cart

The ' Motocart ', manufactured by *S. E. Opperman Ltd.*, is not only designed to do the work of a horse and cart, but it will also do it faster and more economically. It is as simple to drive and as easy to maintain as a motor cycle, and it requires no special maintenance. Fuel consumption is only about 1½ gal. per day.

The ' Motocart ' is a sturdy three-wheeler; the big traction wheel, which is in front, pulls the machine steadily through mud and up slippery gradients. An external ' stop-start ' control makes it possible to lead the machine like a horse, a few yards at a time, when spreading muck or lime, or picking up root or fruit crops. It can travel at 12 m.p.h. on the road and, when the tipping body is removed, the chassis makes an excellent light tractor. It has a 4-speed gearbox and will carry a full 30-cwt. load. Models are available with three different types of body: the standard fixed body, the standard tipping body, and the Lincoln tip cart, specifically designed for work with potatoes and other root crops. The wheel span fits standard potato rows (56-in. centres) and the body, being 9 in. lower than the ordinary farm cart, means that there is 9 in. less to lift every basket of potatoes. Another advantage is that the short chassis provides a simple gravity tip at the right angle for clamp building. It is claimed that the ' Motocart ' is equivalent to three horses and carts.



Washing down a cultivator with the Allman washing unit

Research Sprayer

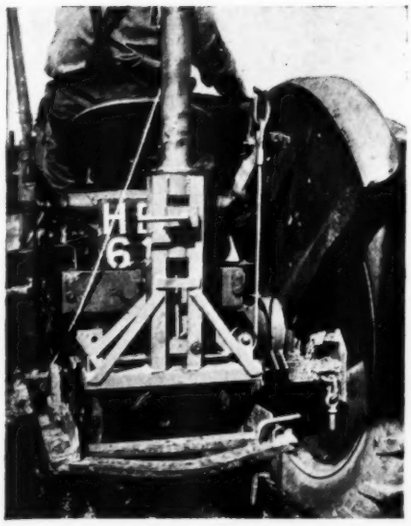
A new all-purpose sprayer, designed specifically to meet the varied sprayer requirements of research, is being introduced by the *F. E. Myers & Bros. Co.*, of U.S.A. This unit, No. 5175, has the performance features of large equipment along with the mobility found in small sprayers. With the aid of supports, the new sprayer can either be mounted on the drawbar or other accessible points of a tractor or it can be truck- or trailer-mounted.

The unit has a 25-gal. spray tank, protected against corrosion by a ' fire-cured ' epoxy coating. A 4-gal./min. pump has ' Ni-Resist ' cylinder shells, replaceable hardened stainless steel valve seats and chrome-plated stainless steel valves. A high-pressure regulator provides a pressure range of 100 to 300 lb./sq. in. and a low pressure regulator offers pressure ranges of 20 to 100 lb./sq. in.

Spray Nozzles and Connectors

A group of split-eyelet spray nozzles and connectors for mounting to spray booms have been designed by *Spraying Systems Co., U.S.A.*, to give greater speed in installation and tight leak-proof clamping.

The clamp parts, which do not come in contact with the chemical being sprayed, are made of cadmium-plated



The 'Vavee' hoist attachment, mounted on the rear of a Fordson Major tractor

steel, which gives extra strength at less cost and will not break or bend; chemical-resistant metals, such as brass, aluminium or stainless steel, are used for the nozzle and connector parts.

The split-eyelet is mounted to the boom simply by drilling a hole of $\frac{5}{16}$ in. diameter in the boom, inserting the inlet of the nozzle or connector body into the hole, placing the upper clamp section in position and tightening the two bolts. These two bolts equalise closure force throughout the clamp and clamp basket.

Known as No. 7421 'TeeJet' split-eyelet spray nozzles and No. 7521 'TeeJet' split-eyelet connectors, sizes are available to fit all standard spray boom piping and tubing. The nozzles may be used with the complete range of 'Teejet' interchangeable orifice tips and the connectors are adaptable to every type of drop pipe need.

Powered Wheel Tiller

The 'Powertiller' is a heavy-duty, powered-wheel cultivator produced by the Bolens Products Division, *Food Machinery Corporation, U.S.A.* It is powered by a 3.6-h.p. engine and has a chain-driven, rear-mounted rotor. The throttle and a self-locking, hinge-type clutch control are both conveniently located on the adjustable handle bars.

The machine is fitted with self-sharpening tines of a new design, which make it possible to introduce large quantities of organic materials into the soil. Weeds, grasses, farmyard manure, compost, and even stubble, are chopped up and mixed evenly into the soil, which, thus enriched, holds moisture better and is properly aerated. A depth shoe controls the depth of penetration of the tines and acts as a brake in very light and loose soils.

The rotor can be operated at four speeds. Two speeds – a low one for tilling and a high for cultivating – are

Cross-section of split-eyelet spray nozzle. The body inlet of the nozzle is of large diameter for ample flow capacity to meet the requirements of even large capacity orifice tips

obtained by changing the driving belt from one set of grooves to another. By changing the sprockets of the side-chain drive two additional speeds are obtained. Forward travel speeds, variable by throttle, range from $\frac{1}{2}$ to $1\frac{1}{2}$ m.p.h.

The 16-tine rotor produces a full 16-in. swathe and a hinged furrowing flap at the rear of the rotor hood levels the soil after the rotor, producing shallow grooves which hold back fine seeds and water and helps to check soil erosion and run-off.

Tractor-operated Hoist

Using the *Becfab* 'Vavee' hoist attachment, sacks, bags, bales etc. can be picked up from ground level and loaded upon a 2 or 4-wheel trailer, drawn by the same tractor as operates the hoist. It has many applications on plantations, farms and market gardens. It will raise a load of $2\frac{1}{4}$ cwt. to a height of 8 ft. at a radius of 14 ft. 6 in. through 360°; it can be charged in a few minutes to raise 4 cwt. up to 5 ft. 6 in. The hoist unit can be fitted to any tractor with 3-point linkage in 10 minutes.

A Correction

In the September issue of WORLD CROPS the output of the fan of the 'Granula' rotary duster at 60 r.p.m. was given as 4,080 cu. ft. per min. instead of a speed of 4,080 ft. per min.

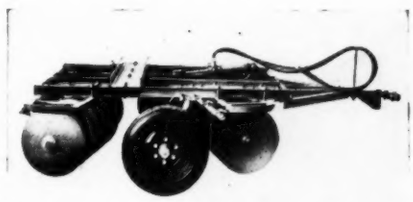
Disk Harrow

The THR 1006/1007 trailed disk harrow – an outstanding new implement – was exhibited by *Ransomes Sims & Jefferies* at the Royal Show.

It is equipped with dual-purpose wheels governed by a double-acting hydraulic ram for transport and depth control. The harrow is one of the new FR range of implements specially designed for the *Fordson* 'Dexta' tractor.

Precision Planting

A new precision planting unit for planting maize, beets, beans, vegetables and most other crops has just been announced by *International Harvester Export Co.* The new McCormick International No. 185 planting unit can be mounted on any $1\frac{1}{2}$-in. to $2\frac{1}{4}$-in. sq. toolbar to make a two-, four- or



The FR THR 1006/1007 trailed disk harrow

Bolens Model 70 'Powertiller'. Simplified controls and adjustable-height handles give easy operation

The McCormick International No. 185 planting unit, as mounted on the toolbar of a tractor

six-row planter with minimum row spacing of 14 in. The number of rows that can be planted in one run naturally depends on the row spacing and the length of the toolbar.

Each unit is independent and free to follow the contour of the ground. Two large down-pressure springs hold the double-disk openers in the ground and depth bands accurately regulate planting depth. Each planting unit is powered by a full-floating drive and press wheel. A variety of different seed plates plus four sizes of drive sprockets provide a total of 182 seed-rate combinations, and seeds can be spaced from 0.8 in. to 69.7 in. apart in the row.

Other features of the new planter include ½-bushel window seed hoppers at low level for convenient filling and ratchet-action seed plate drive that prevents damage should the planter be accidentally backed while it is in the ground.

The No. 185 planter can be ordered either as a complete unit for two to six rows, or individual row units can be bought and assembled on an existing toolbar according to requirements.

The 'Sprayscale'

Fruit and hop growers, and tea, coffee and rubber planters may be perplexed at the calculations involved in the determination of the nozzle output (gal./min.) necessary to give the desired application rate (gal./acre) at a certain tractor speed (m.p.h.) with either double- or single-sided spraying. The 'Sprayscale' of *Drake and Fletcher Ltd.* is a slide rule, which is simple to operate, gives the answer direct, obviates mistakes and eliminates all guesswork and approximations.

Reader Service

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Potato Harvesting

After extensive tests *Morris Motors Ltd.* have approved the use of the 'Solari' mounted elevator potato digger, No. 57, produced by *John Wallace & Sons Ltd.*, with their tractors. This can dig two 24-in. to 28-in. rows at a time and collects the tubers into one row for easy gathering. The machine is particularly suitable for early potatoes, as there is almost complete freedom from damage.

Parkland Into Pasture

Wheat, barley and oats are now growing in a Domesday deer park for the first time in 900 years. In spite of difficult weather conditions and the hilly terrain, the grain is being harvested and threshed by a Massey-Ferguson 780. In a previous issue we gave an account of the preparation of the land in 1957, using four *Massey-Ferguson* tractors and their ancillary equipment (see WORLD CROPS, 1957, **9**, 423).

The success of this venture, which was the elimination of all bracken and the establishment of pasture, is now assured. In the clay areas the bracken has not come back, but in the lighter sandy soils, where the roots go down to more than 2 ft., some stunted growths are reappearing in isolated patches, and further cultivations and planting with arable crops will be necessary before a permanent ley can safely be established.

In all some 300 acres have now been brought under cultivation. Originally a few acres were planted with Proctor barley as a test planting and then in May 1957 38 acres were sown with S172 winter oats and manured with 1½ cwt. of *Fison's* triple superphosphate per acre, while 2 tons of *I.C.I.* nitro-chalk were also rolled in.

This year 70 acres were sown with Atle wheat at 3–3½ bushels per acre and a crop of 1 ton per acre has been recovered in the first major cereal harvest, but, as previously explained, this is only an incidental phase in the conversion of the old deer park of Eridge Castle into useful pasture land.

Left: *Members of the Press, officers of the N.A.A.S., Ministry of Agriculture, and officials of the National Farmers' Union inspect the bracken-infested area, scheduled to be ploughed during the next phase of the reclamation work*

Right: *Almost complete control of the bracken has been achieved with the exception of one or two patches on the lighter land. The Massey-Ferguson combine-harvester was able to deal satisfactorily with both corn and bracken*

Agricultural Chemicals

new sprout depressant; soil sterilisers; fungicides and insecticides

Potato Sprout Depressant

A new product – *I.C.I.* nonanol sprout depressant – is now available for farmers who use indoor storage for their potatoes. Applied by a simple fumigation technique, nonanol ensures that healthy potatoes will be unwilted and free from sprouts at the time of marketing, no matter how long they have been stored.

It has long been known that alcohol vapour has an inhibiting effect on the sprouting of potatoes. Nonanol, which is one of the higher alcohols, is sufficiently active even at low concentration to make it a really effective and economic sprout depressant.

In trials carried out under typical farm conditions in collaboration with farmers and the D.S.I.R., nearly 900 tons of potatoes were treated by the fumigation technique. Nonanol vapour was applied intermittently between November 1957 and April 1958, at times when inspection showed that the 'eyes' were active; as a result, the dormancy of the tubers was increased and under complete control.

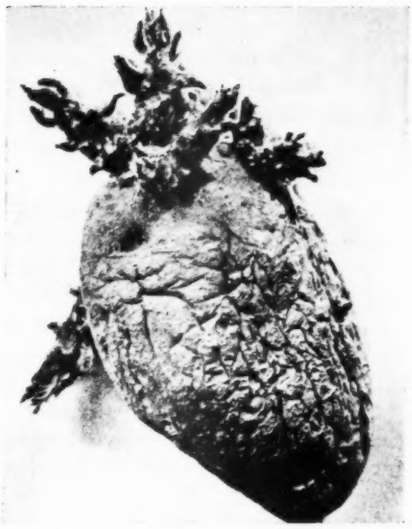
An important feature of this fumigation technique is that it is complementary to the ventilation system recommended by the Ministry of Agriculture, Fisheries and Food for indoor stores, for it is applied only when potatoes show signs of sprouting and it is discontinued when dormancy is achieved. No taints or unsatisfactory flavours have been detected.

Nematode Control

Not so many years ago, nematodes were a major agricultural problem. We knew what they were and what they were doing to our crops, but we had scarcely any idea what to do about them.

Then the chemical companies began experiments in soil fumigation. These first attempts at control were costly and required a considerable amount of equipment, but they seemed to be on the right track.

They kept on trying always for a better and a cheaper way of doing the job. Now a brand-new nematocide is



Nonanol will prevent sprouting

on the market which seems to have solved some of the earlier difficulties.

The new chemical, DBCP, is being marketed by two major chemical companies in the U.S.A. It is a granular product which can be blended with fertilisers and applied as a side dressing, either at times of, or within 10 days of planting, according to the *Lawrence Robinson* Newsletter.

Sterilising Soil

The sterilisation of glasshouse soils is a routine practice in commercial greenhouses and generally involves the use of steam or chemicals. Some growers use steam in some years and chemicals in the alternate years, but chemical sterilisation is cheaper and quicker than steaming and, with the range of chemicals available, it is possible to deal effectively with all the particular problems of the nursery.

'Vapam', produced by the *Murphy Chemical Co. Ltd.*, is a new all-purpose steriliser which will control soil fungi, eelworms and weeds, all at the same time. Its use does away with the need for treatment with three different chemicals and thus is labour-saving. The makers claim that it is effective against the spores and mycelia of many diseases, including *Verticillium*, *Fusarium*, *Didymella*, *Rhizoctonia* spp., *Phytophthora* and *Pythium* spp. It is effective for the control of *Colletotrichum* and other root rots. It has given good control of both potato root eelworm and root-knot eelworm and, at the same time, of weeds, including *Oxalis*, for up to three months.

Fisons (Canada), Ltd.

In the field of pesticides *Geigy* and *Fisons* are already collaborating on a world basis in research, development and distribution. Now comes news of a further important development – the incorporation of a Canadian-domiciled company under the name of Fisons (Canada) Ltd.

The overseas activities of Fisons commenced in 1946, when Pest Control (Central Africa) Ltd. was formed in Southern Rhodesia to organise the control of the jassid insect pest of cotton. In 1947 Pest Control (South Africa) Ltd. was initiated, and in 1948 Pest Control (East Africa) Ltd. was launched.

Most of the products which will be handled in Canada will be either new or relatively new to farmers in that country. The problem of weed control in maize, a very serious problem in Ontario, has not been satisfactorily solved, but it is a problem with which the company has been familiar in Africa and an early solution is therefore probable. Another problem which needs to be effectively tackled is the control of unwanted vegetation on embankments and factory sites – generally described as industrial weed control. These are but two examples of the way in which the new company can contribute to the economic development of Canada.

Tobacco Diseases

One of the serious diseases affecting tobacco crops, particularly in Central Africa, is tobacco anthracnose. 'Unicrop Zineb +', an active fungicide based on zinc ethylene bisdithiocarbamate with special additives, will control this and certain other diseases in tobacco. The particles are extremely fine and it is easily dispersible in water; applications should be made twice weekly, commencing three weeks after

sowing, at 3 oz. in 25 gal. water per seedbed of 30 sq. yd. until the tobacco leaf is about the size of a shilling. Then applications should continue twice weekly at 6 oz. in 25 gal. water per seedbed until planting out. The product is manufactured by *Universal Crop Protection Ltd.*; it has also proved a most active fungicide against several diseases in other crops, such as potatoes, citrus and tomatoes.

Apple Fungicide

'Sulpham' has been specially formulated by *F. W. Berk & Co. Ltd.* to meet the threat of the recent increase in apple mildew, as a micronised formulation, which combines 'Phelam' – an organo-mercury spray – with sulphur to provide a dual-purpose fungicide to control both apple scab, *Venturia inequalis*, and apple mildew, *Podosphaera leucotricha*. The active ingredients are 0.6% phenyl mercury dimethyl dithiocarbamate (0.3% Hg) and 60% sulphur.

It is a pale yellow powder containing its own wetting agents which mixes easily with water and is not corrosive. It is used at the rate of 5 lb. in 100 gal. of water; the first application should be made not later than 'green bud' and thereafter at fortnightly intervals unless there is exceptional spore discharge requiring more frequent applications.

'Sulpham' should obviously not be used on sulphur-shy varieties of apples, such as Lane's Prince Albert, Newton Wonder, Beauty of Bath, Rival, Duchess Favourite, Stirling Castle, St. Cecilia, Lord Derby, Belle de Boskoop. With Cox's Orange Pippin the customary care should be exercised, although no damage has been recorded where 'Sulpham' has been used.

Reader Service

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England

A field of spring onions which was part sprayed with 'Isofen' last October and photographed in the following April. The unsprayed portion (left) *shows very considerable weed growth and a lighter crop; the sprayed portion* (right) *is entirely free of weeds. The manufacturers are W. J. Craven & Co. Ltd.*

Dow Agrochemicals Ltd.

This is the name of a new chemical manufacturing company which has recently been formed in Britain and with which the name of Dr. W. E. Ripper is associated as managing director.

The first stage of the development programme of the new company aims at the manufacture of a range of *Dow* agricultural chemicals in the U.K.; the first product to be marketed is the important new systemic grass weedkiller, 'Dowpon', which, it is claimed, can cheaply and easily solve the problem of the creeping menace of couch grass. This pest has become the main weed danger to growers of cereal crops, and to dairy farmers who depend on leys, since other chemical weedkillers satisfactorily control other weeds, but are generally ineffective against couch. The result is that, left alone after such treatments, the couch will flourish more than ever.

'Dowpon' is a selective weedkiller based on 2,2-dichloro-propionic acid. It is claimed to be effective against bracken and against a number of tropical weeds, including the plant-killer lalang, or illuk, *Imperata cylindrica*, and *Echinochloa* spp. in the ricefields.

Glycol as a Stabiliser

The discovery that small amounts of a well-known solvent can extend the useful life of a mite- and spider-killing compound by as much as 70 times has been reported from America.

According to the senior chemist of the Niagara Chemical Division of the *Food Machinery and Chemical Corporation*, of U.S.A.: 'Though the pesticide "Aramite" contains chemicals which protect it before formulation, its strength drops off when it is incorporated in powders or other forms for application, and stored in paper bags and cartons at temperatures encountered in stores and warehouses.

It has been discovered that dipropylene glycol can be added to 'Aramite' to increase its usefulness from 10 days – under the most severe conditions of storage – to two years. Tests have indicated that the addition of 2% dipropylene glycol greatly increases the stability of 'Aramite', even in hot and dry regions when the temperature rises to 110°F.

World Crop Reports

Wheat—new record expected

INTERNATIONAL REPORTS

Wheat

World wheat production in 1958 is expected to set a new record, according to preliminary information. Increases indicated for the three leading wheat producers, the U.S., the U.S.S.R. and China, are so large that they will more than offset any possible decline in countries not yet reporting, especially in the Southern Hemisphere. The record outlook for these three countries, which normally account for almost half the world wheat production, is the outstanding feature of the present situation.

Conditions are varied in Canada, Argentina and Australia, which, with the U.S.A., are the four principal exporters. Prospects are relatively unfavourable in Canada, and an out-turn of less than the below-average crop of 370 million bushels harvested last year is expected. However, the outlook for Australia is better than in 1957. Acreage is reported to be 40% larger and moisture conditions much more favourable than last year, when drought cut production to about half the normal crop. The acreage recently seeded in Argentina is not much above that of a year ago.

World wheat trade possibilities are limited by relatively good supplies in many normally import markets of Western Europe and Asia. Reports from Europe are incomplete, but it now appears that total wheat production in *Western Europe* may be around the high 1957 level. Conditions are less favourable than last year in *Eastern Europe* and total production is expected to be significantly lower. Wheat production is less than in 1957 in many countries of *Asia*, but stocks have been carried over from the bumper crops of last year.

U.S. wheat supplies at the beginning of the 1958–59 marketing year are estimated at a record 2.3 billion bushels. Though the carry-over into the new year was slightly less than in 1957–58, the large increase in production brings supplies 24% above last year's total. Supplies will also be large in *Canada*, though not up to the 1.1 billion bushel supply for the 1957–58 year. Both carry-over and production are expected to be less than last year. *Argentina's* supplies for the remainder of its marketing year are also not as large as usual.

North America's 1958 wheat crop may be about a third larger than in 1957 because of a record U.S. crop. As estimated on 1 August, U.S. production will be 1,421 million bushels, which exceeds the previous record by 62 million bushels. The present estimate is 50% above the 1957 harvest. Record yields account for the large crop, since acreage for harvest was 10 million acres below average, though well above the small acreage harvested last year.

Winter wheat is estimated at 1,171 million bushels, 10% above the previous record. Spring wheat is estimated at 250 million bushels, 6% below average. *Yields set a new record, although acreage is about 6.5 million acres less than the 1947–56 average.*

Most of the countries of *Asia* have smaller wheat harvests than the large 1957 crops, but the total for the area may be considerably larger because of the record crop claimed for China. Pre-harvest forecasts indicated that production would be at an unprecedented level. Such an increase would much more than offset reductions reported for India, Syria, Turkey, Iraq and Japan.

Wheat production in *Africa* appears to be larger than in 1957, mainly because of better crops in Morocco and Tunisia. Slight reductions are reported for Algeria and Egypt. It is too early to estimate the out-turn in the Union of South Africa, where harvesting does not begin until November.

In *Australia*, wheat acreage is about 40% above 1957 and moisture conditions are much more favourable. Present prospects indicate that a normal crop may be harvested. Last year's harvest was only about half an average crop because of severe drought.

Citrus

The 1957 citrus season has been marked by increased production in the Mediterranean area. Crops in *Italy* and *North Africa* are up and *Spain* has made a remarkable recovery from the 1956 freeze. *North American* production is down sharply, despite increases in Mexico; the winter freezes in Florida were largely responsible for the decrease.

North America is the only major producing area showing a substantial decrease in orange production in 1957 compared with 1956. Commonwealth countries of the southern hemisphere are down slightly. The Mediterranean area is up about 17%, South America 7% and the Far East 3%. However, the decrease in North America (almost 15%) more than offsets gains elsewhere. Total world production of oranges is down 1.5%.

The picture for 1957 world grapefruit production is similar to oranges, with most major areas producing at about the same as in 1956, or higher. But production in the U.S.A., South Africa and Australia is down sufficiently to cause a decrease in the world total of almost 9%.

U.S.A. and Italy continue as the major producers of lemons. Both report 1957 production down slightly from 1956 and world total is correspondingly lower. Greece, next to Italy as the most important producer in the Mediterranean, shows a substantial production increase, which continues the trend of recent years.

REGIONAL REPORTS

French Equatorial Africa

Cotton production in French Equatorial Africa is estimated at 160,000 bales (500 lb. gross) for 1957–58. This is slightly more than the 1956–57 crop of 155,000 bales. The increase was attributed to favourable weather during the growing and harvest seasons. The area planted to cotton this season declined to 775,000 acres, compared with 785,000 acres last year.

India

The first official estimate places India's 1958 *wheat* acreage at 29,576,000 acres, compared with the corresponding 1957 estimate of 30,782,000 acres. India's first estimate of grain acreage does not cover the entire country's acreage, but is usually about 90% of the total finally reported.

The decrease in Indian acreage for the current year is attributed to lack of monsoon rains at seeding time in some parts of the country. The principal districts reporting reduced acreage are Bihar, Madhya Pradesh, Uttar Pradesh and Rajasthan. Some increase in the wheat acreage of the Punjab and Himachal Pradesh partly offset the reduction in dry areas.

Condition of the crop is described as generally satisfactory, except in the dry districts mentioned. The drought there has been prolonged and as a result private forecasts of the harvest now under way are significantly below the country's 1957 final estimate of 338 million bushels.

Yugoslavia

The 1958 commercial pack of Yugoslav *walnuts* is unofficially forecast at 2,900 short tons, unshelled – 800 tons more than the 1957 pack, but 800 tons less than average production (1951–55) of 3,700 short tons. Drought reduced earlier prospects for a large crop.

Drought in Serbia and parts of Bosnia has also sharply reduced Yugoslavia's *prune* crop prospects. The 1958 dried prune pack is now forecast at about the same level as last year, when 19,600 short tons were produced. Average production (1951–55) is 22,300 tons.

Sudan

Cotton production in Sudan is now unofficially estimated at 225,000 bales (500 lb. gross) for 1957–58. This is a drop of 64% from last year's record crop of 617,000 bales, and is 49% below the 441,000 bales produced in 1955–56. The 1957–58 area of 728,000 acres planted to cotton was slightly smaller than the 764,000 acres in 1956–57.

The main decrease was in the extra-long-staple varieties, which amounted to only 165,000 bales, against 582,000 bales in the previous season. The sharp drop was caused by adverse weather, insects, disease and smaller acreage due to poor flooding.

Production of American-type cotton, mostly rain-grown, amounted to 60,000 bales, compared with 36,000 bales in 1956–57. This increase was attributed primarily to an increase in area from 167,000 acres in 1956–57 to 214,000 acres this season.

England and Wales

Weather conditions during August were wet and unsettled with frequent thunderstorms. The heavy rains caused local flooding, particularly in the South.

The harvesting of *cereal crops* was seriously retarded by the unfavourable weather, which delayed ripening and made the use of heavy machinery difficult. Heavy localised storms aggravated the position and caused considerable damage. Lodging was fairly widespread, particularly in barley and oats. The conditions were conducive to sprouting and high moisture content of the grain.

Forecasts of average yields as at 1 September are given below. *Wheat* generally was standing well, although lodging was reported from several areas. 'Take-all' was prevalent in some places and sprouting was also reported. On the basis of crop conditions at the end of August, the yield of wheat was estimated to be 25.1 cwt. per acre, as compared with 26.9 cwt. a month earlier, a five-year average (1953–57) of 24.7 cwt., and a yield of 25.3 cwt. in 1957. All areas reported that *barley* crops were lodged to some extent, many severely, with weeds and undersown seeds growing through.

The yield of barley is estimated at 22.1 cwt. per acre, as compared with 24.7 cwt. a month earlier, a five-year average of 23.1 cwt. and a yield of 22.3 cwt. in 1957. *Oats* were badly lodged in all areas. The yield of oats was estimated to be 19.3 cwt. per acre, as compared with 20.8 cwt. a month earlier, a five-year average of 20.1 cwt. and a yield of 18.7 cwt. in 1957. Few crops of *mixed corn* had been harvested; the yield was expected to be 19.7 cwt. per acre, as compared with a five-year average of 20 cwt. and a yield of 19.3 cwt. in 1957. *Rye* was expected to yield 19.8 cwt. per acre, as compared with a five-year average of 19.4 cwt. and a yield of 19 cwt. in 1957.

The harvesting of pulse crops has also been seriously retarded by the weather. 'Chocolate spot' on *beans* for stock was reported from several areas and there has been some aphid damage. The yield was forecast at 13.2 cwt. per acre, as compared with a five-year average of 17.5 cwt. and a yield of 17.8 cwt. in 1957. Losses of *peas for stockfeeding* has been considerable and the yield is forecast at 10.3 cwt. per acre, as compared with a five-year average of 13.6 cwt. and a yield of 13.8 cwt. in 1957.

Potato blight was widespread over the country. In many areas haulms were completely destroyed and tubers affected. Further damage to tubers by waterlogging was reported from eastern areas. On the basis of conditions at the end of August, the yield of second early and maincrop varieties is expected to be 7.3 tons per acre, as compared with a five-year average of 8.4 tons and a yield of 7.7 tons in 1957.

Sugar-beet crops generally were satisfactory on lighter soils, but backward on heavier land, due to prolonged waterlogging. Virus yellows were reported to be spreading in many districts. The yield per acre of roots was expected to be below average.

Except on heavy land where waterlogging has occurred, *mangold* crops were reported to be healthy: the yield per acre was expected to be slightly below average. *Turnips and swedes* were generally satisfactory and making good growth, but diamond-back moth had caused widespread damage in some northern districts and the yield per acre was expected to be below average. *Kale* was generally satisfactory, but weeds were prevalent in all root crops.

Hay harvesting has been very difficult and little was made during August. Its condition was generally poor and its feeding value is expected to be low. The yields of hay from *temporary grass* and *lucerne*, as forecast at the end of August, were 31.6 cwt. per acre and 40.2 cwt. per acre respectively, as compared with yields of 28.4 cwt. and 40.8 cwt. in 1957. The yield of hay from *permanent grass* was expected to be 22.6 cwt. per acre, as compared with 21.1 cwt. in 1957. Some late summer silage had also been made.

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